

**THE AGRICULTURAL ECONOMY AND FOREST LAND USE OF
THE LOWLAND TROPICAL FORESTS
OF MADRE DE DIOS, PERU**

by

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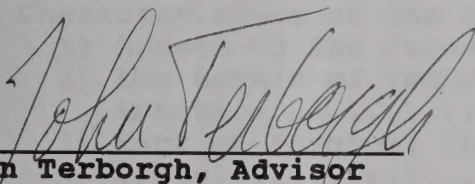
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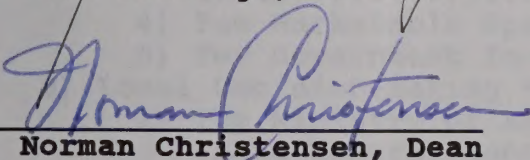
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Abstract

This report investigates the effects of government incentive programs and land use policies on the agricultural economy of Madre de Dios. The various land uses which have been promoted in the Subregion will be described and the present state of management of these lowland tropical forests will be discussed. The report provides a critical look at the forces which have determined the settlement and land use patterns in Madre de Dios and critiques the inappropriate policy decisions which have characterized the efforts to develop the Subregion.

The research was conducted in Peru during the months of May through August 1991 in Madre de Dios, Cusco, and Lima. The information contained in this report was collected through interviews, independent research, observations in the field, and numerous other sources. There are very few studies available which describe the agricultural economy or the present state of the tropical forests of Madre de Dios. This dearth of basic scientific data, economic analyses, and planning has greatly restricted the development of appropriate management strategies for the forested lands of the Subregion.

Many of the government-sponsored incentive programs and colonization schemes which have been created to develop Madre de Dios have resulted in great economic and financial losses. The agricultural economy no longer benefits from the important government subsidies and credit programs which have been historically available and many rural settlers may be forced to abandon commercial agriculture in favor of extractive activities, notably selective logging and gold mining. Furthermore, due to the absence of adequate social and physical infrastructure, the Subregion will not achieve the anticipated economic growth and the ecological integrity of the lowland tropical forests will become further degraded unless certain crucial policy reforms are implemented.

Several recommendations and policy alternatives are presented which could aid in the development of a more sustained management plan for the forested lands and natural resources of Madre de Dios. The government of Peru must recognize the failures of past policies affecting tropical forested lands and implement a sustainable development strategy within the existing economic and ecological limitations. The following policy improvements should be investigated for Madre De Dios: All colonization programs must be suspended; Perverse economic incentives which promote indiscriminate settlement and degradation of the tropical forests should be removed; Intensive agricultural and forestry systems should be promoted in the marginal or secondary forest lands; Extension agencies and scientific research facilities should be supported and a comprehensive soil survey and forest inventory should be completed; The Ministry of Agriculture and local government need to concentrate on sustained, long-term development strategies which should include further promotion of agroforestry, perennial crops, national parks and reserved areas, extractive reserves, and ecotourism. These alternative management programs must be put forth to provide local decision-makers in Madre de Dios and other tropical forest areas with greater tools to apply towards a sustainable development of these lands.

I. Introduction

The central government of Peru has recently initiated a program of reforms aimed at stabilizing the economic, social and political structures of the country. These policy decisions involve efforts to combat inflation, trim the government's cumbersome bureaucracy, reduce the levels of public investment and subsidies, and allow market forces to operate freely in a country still suffering greatly from policies which have promoted substantial government intervention into many aspects of Peruvian society.

One sector which has received important government incentive programs and "reforms" is agriculture, which encompasses all farming, livestock, and forestry activities. These incentive programs have ranged from low-interest loans provided through the Banco Agrario to subsidized agricultural inputs and government-sponsored colonization schemes. Some regions of the country which are of major interest to the central government's development planners are the extensive tropical forests which cover nearly 62% (about 79 million hectares) of the country's land area.

Several government administrations have actively promoted settlement of the eastern forest regions in the hope that these efforts would achieve several important national objectives: (1) These areas could become important centers of agricultural production; (2) The population pressures affecting other areas of the country could be alleviated; (3) Peru's remote border regions with Brazil, Ecuador, Bolivia, and Colombia would become settled by nationals and these areas would be easier to protect from foreign invasions; And, (4) the

vast natural resources of the tropical forests could be exploited and provide the country with much needed revenue. Of course, as we have recently learned, the objectives which were set for these regions have remained largely unrealized.

The most isolated and underdeveloped part of Peru is the southeastern Subregion of Madre de Dios, an area of approximately 83,000 km² dominated by various types of tropical forests ranging from montane cloud forests on the east to lowland tropical forests on the west (see Appendix A). Madre de Dios has recently been united with the former departments of Cusco and Apurimac to form the Inka Region through a process of "regionalización" which seeks to decentralize the administration of the country and promote autonomy for the various regions.

This report investigates the effects of government incentive programs and land use policies on the agricultural economy of Madre de Dios. The various land uses which have been promoted in the Subregion will be described and the present state of management of these lowland tropical forests will be discussed.

My research was conducted in Peru during the months of May through August 1991 in Madre de Dios, Cusco, and Lima. The information contained in this report was collected through interviews, independent research, observations in the field, and numerous other sources. There are very few studies available which describe the agricultural economy or the present state of the tropical forests of Madre de Dios. This dearth of basic scientific data, economic analyses, and planning has greatly restricted the development of appropriate management strategies for the forested lands of the Subregion.

The various sections of this report provide a critical look at the forces which have determined the settlement and land use patterns in Madre de Dios and critique the inappropriate policy decisions which have characterized the efforts to develop the Subregion.

The agriculture and forestry sectors are of particular importance and are described in some detail in sections II, III, and IV. Section III closely examines the financial well-being of a representative farm to assess the importance of government support programs to the rural settlers of the area. Gold mining, the most important economic activity of the Subregion is described in section V.

Following the introduction and description of the agricultural economy and forest land use problematic, section VI outlines the various types of incentives which have been utilized by the government to promote agriculture and settlement of the Subregion. Several recommendations and policy alternatives are then discussed in section VII which could aid in the development of a more sustained management plan for the area's forest lands and natural resources.

This report highlights the lowland tropical forests of Madre de Dios and the specific policy improvements may not be readily applicable to other locations or ecological zones of the neotropics.

The present situation of uncontrolled settlement, distorted relative prices and local markets, extractivism, insignificant private investment, ill-conceived colonization schemes, and bureaucratic sub-optimization has its roots in the historical isolation, the numerous environmental constraints to development, and the lack of an adequate infrastructure which have characterized human occupation of the forested Amazon regions of Peru.

It is entirely possible that "there is no economically profitable alternative use known for large areas of biologically highly productive tropical forests" (Schmidt, 1991). Nevertheless, some important ideas are being generated by the international scientific, economic, and political communities and these alternative management programs must be put forth to provide local decision-makers in Madre de Dios and other tropical forest areas with greater tools to apply towards a sustainable development of these lands.

II. Agriculture: Shifting Cultivation

The most prevalent land use in Madre de Dios and other regions of the upper portion of the Amazon basin is shifting cultivation and this activity is the primary cause of forest conversion and degradation in the Subregion (Nicholaides, 1985).

The majority of the area's inhabitants are relatively recent settlers from the highlands who have migrated to this area attracted by the lure of virtually free land, government-financed colonization schemes, gold mining, and the various incentive programs which have characterized settlement in much of the upper Amazon Basin. These colonists have migrated away from the Andean highlands because these regions have become increasingly overpopulated, farm size continues to decrease, and the steep lands have been exploited for centuries. These factors have resulted in "widespread soil erosion, siltation of reservoirs, and other adverse off-site effects to urban centers" (Sanchez, et. al., 1990). In addition, the increasing violence of the two principal terrorist groups, Sendero Luminoso (Shining Path) and the Movimiento Revolucionario Tupac Amaru (MRTA), coupled with the heightened activities of cocaine traffickers in the highlands and northern and central forests, have also caused massive migrations to Lima and the southern tropical forests.

Upon arrival in Madre de Dios, these settlers acquire a plot of land either by following the official procedures of the Ministry of Agriculture or by simply occupying land that is not presently in use and becoming de facto "owners" of the land. These settlers or "colonos" (numbering about 5,000 households in Madre de Dios), represent the disadvantaged economic and social strata of the Peruvian

population and the majority are farmers or wage-laborers hoping to increase their wealth and standard of living in these vast new territories. However, many of these families begin to recognize the harsh realities of living in this environment soon after settlement.

The soils, natural landscape, climate, and other physical and biological characteristics of the tropical forests of Madre de Dios present a very distinct set of land use possibilities than those of the Andean highlands. Invariably, these factors force the settlers to adopt a system of agriculture similar to that practiced by the native Amazonian inhabitants who have been living in the area for millennia. However, as we will see, the "modern" (or invasory) version of shifting cultivation developed by settlers from other regions of Peru differs substantially from the traditional (or cyclic) methods of shifting cultivation employed by the native inhabitants.

A) Slash and burn

Shifting cultivation or slash-and-burn agriculture consists of clearing a patch of primary or secondary forest and burning the felled vegetation to remove the debris. The ashes deposited on the site are incorporated into the topsoil and "produce a temporary increase in overall soil fertility (increased pH, total nitrogen, available phosphorus, exchangeable potassium, calcium, magnesium, and some micronutrients) and a concomitant decrease in exchangeable aluminum to below toxic acidity levels" (Nicholaides, 1985). This method of clearing the plot of forest to be cultivated is very similar to the traditional techniques used by native Amazonian peoples for many centuries. The native inhabitants of the tropical forests generally

leave the more valuable tree species such as Swietenia macrophylla, Cedrelinga cataneiformis, Cedrela odorata , palms, fruit trees, and other valuable plants that may be of use later. In the plots cleared by recent colonists most of these valuable trees and plants are removed and larger areas are cleared at any one time. These factors lead to a less complete regeneration of the forest following this "modern" variety of shifting cultivation.

Burning the vegetation that has been slashed remains the best option for the conversion of tropical forests to agricultural uses and much of the research in sustained cultivation in the tropics utilizes this method of land clearing. In contrast, the use of heavy machinery such as bulldozers, can have very detrimental effects on soil structure (compaction and topsoil displacement) and the field does not benefit from the ashes left after burning (Seubert, 1977). In Madre de Dios, the lack of mechanization in agriculture and forestry activities forces the area's farmers to continue the practices of burning and the removal of the woody debris is carried out by manual labor. Also, the limited availability and use of chemical fertilizers necessitates that burning be included in the agricultural production cycles to ensure some maintenance of soil fertility and minimum loss and disturbance of the shallow organic layers characteristic of the Ultisols of the upland sites. The recent failure of ENCI (the public agency responsible for the provision of agricultural inputs to local farmers) has also set back the process of modernization of agricultural techniques and further diminished the likelihood that local farms will develop sustained intensive cropping technologies.

B) Cropping

After clearing a plot of forest during the dry months to facilitate burning (May through August), a crop is planted generally consisting of some combination of rice, corn, bean, cassava (or manioc), and plantain. Again, in contrast to the shifting cultivation of the traditional societies of the Peruvian Amazon, the colonists generally plant many fewer kinds of crops which decreases the diversity of the plots and makes the crops more susceptible to weeds, pests, and disease outbreaks. The reduced variety of crops also increases the economic risk of losing the entire crop to unpredictable environmental or biological factors (Dove, 1983).

In this region upland rice is the favored crop on plots of newly cleared forest because this crops has a high market value and the maximum yields are achieved in the first year of production. The average yields drop during the period of cultivation from about 1500 kg/ha on a newly cleared field to 500-700 kg/ha on a two year-old field. Following this decrease in the average crop yields on continuously cultivated fields after two or three annual cycles, the plot must be left fallow for several years or is converted to pasture. The continued exploitation and intensive management of a cleared field may in extreme cases lead to permanent loss of the forest's regenerative potential (Uhl et al., 1988) (See Appendix B).

Abandonment of agricultural land by settlers who have no intention of returning to that same location also occurs frequently when the agricultural, forestry, and/or pasture potentials of that land have been significantly degraded. For this reason, the amount of land under cultivation in any given year is usually a gross underestimate

of the land area that should be classified as agricultural land and thus devoid of mature tropical forest. There exists a substantial area of abandoned agricultural lands (in a state of "purma" or shrubland) which have sustained previous exploitation which should be recuperated and made productive. The recuperation of these "purmas" would relieve some of the pressures to clear mature forests and should be an important component of a sustained management plan for these tropical forests.

C) Fallow

Optimally, the fallow period should be of at least 10 years to allow the regeneration of the soil nutrients and the development of a suitable organic layer before the process of clearing and cultivating the plot is repeated (Brady, 1990).

The length of fallow is the most important factor differentiating the traditional and settler methods of shifting cultivation. Native Amazonian peoples generally allow the forest to recover during a relatively long fallow period before returning to the same plot to repeat the processes of clearing and cultivation. For example, the Bora of northern Peru say that "a minimum of ten years of fallowing is needed before a plot can be cut and planted anew" and most of their fields are left in fallow for over 20 years or more (Denevan, 1984). This long fallow contributes to the sustained nature of traditional modes of shifting cultivation. The soils are not excessively depleted of nutrients or physically altered, which ensures that the site will recover normally, following the principals of natural forest regeneration.

Settlers in Madre de Dios generally opt to clear new areas of primary forest instead of returning to previously cultivated plots because the clearing of new land has some significant advantages. In many instances the clearing of forest will provide a settler with proof that the land he/she is occupying is being utilized productively. This perception of "improving" the value of land through clearing is widespread throughout the world's regions of tropical forests (Dourojeanni, 1990 and Fearnside, 1984).

In Brazil, for instance, many government tax incentives and credits have been obtained by landowners and squatters simply by turning the forests into pasture. Indeed, this practice of forest conversion has led to widespread land speculation in the western and southern regions of the Brazilian Amazon, a phenomenon that Madre de Dios has not experienced to a significant degree because very few wealthy Peruvians have shown interest in exploiting the resources of the southeastern forests. Also, land speculation requires that the price of land increase in value through time to warrant the buying and selling of such land, but the commercial value of land in the Peruvian Amazon regions is insignificant and land continues to be treated as a "free" commodity. This problem of undervaluing the land resource in the areas of tropical forest further complicates the need to develop a sustained management of these forests.

The principal components of land use policy are reviewed in the following section which will develop an economic analysis of a representative farm in the lowland tropical forest areas of Madre de Dios. This case study describes the present state of the agricultural

economy of Madre de Dios and outlines the factors which determine the land use decisions made by the rural settlers of Madre de Dios.

III. The Agricultural Economy of Madre de Dios, Peru

Case Study: Financial and Economic Analyses of a Representative Farm

In order to quantify the present financial condition of the small family-operated farms in the region of Madre de Dios, a representative farm has been analyzed using the most reliable data available. The practical difficulties of carrying out a detailed study of the very informal and largely subsistence agricultural practices of this region require the utilization of a representative or "average" farming situation with which to conduct the appropriate economic analyses.

The data were collected from government documents, technical pamphlets, a number of agricultural publications, personal observations, and from numerous interviews with farmers, NGOs, extension agencies, banks, and development institutions throughout the Subregion.

The analysis will be carried out for an upland rice farm with varying income portfolios (or scenarios) and located at different distances from the principal market in Puerto Maldonado. Rice is the principal commercial crop which has been promoted by the government in an effort to develop the agricultural production of the area. It will be assumed that the cultivation of upland rice is the principal income-generating activity of the representative farms. Most farmers in Madre de Dios also rely on other activities, notably wood extraction and gold mining, to supplement their income from the sales of agricultural products. The extent to which these secondary activities contribute to the farm's annual income will be considered

in the analysis of present agricultural policies and the elaboration of the necessary cash flows.

The other principal crops, notably maize, yuca (also known as manioc or cassava), plantain, frijol (beans), and citrus will not be included in the case study because these products have not been strongly emphasized by the government's incentive programs and generally represent a small proportion of the region's commercial agricultural output. Also, these crops are not a significant source of income for the region's farmers who consider upland rice to be the most economically profitable crop. However, these other crops are very important food sources for local consumption and figure prominently in the Subregion's subsistence agriculture (see Table 1).

The small family farms of Madre de Dios and other areas of the Peruvian Amazon generally maintain a variety of secondary seasonal or perennial crops to supplement their diet and as a source of food throughout the year. Interviews with several farmers along the two principal roads in the region (Puerto Maldonado - Quince mil and Puerto Maldonado - Iberia) indicate that, in general, approximately .5 hectares is cultivated with each of any number of these subsistence or secondary crops (David Ricalde, pers. comm.). The labor required to maintain these other crops will be included in the total labor provided by the family unit (see Appendix C).

A) Methods:

The first step in performing the economic evaluation of a representative farm is to construct a series of cash flows to estimate the farm's sources and uses of cash or funds. The prices which are

used in this first step include all the distortions which may occur due to government interventions such as low-interest loans, credit programs, or other artifices which have a significant effect on the region's agricultural sector. The distorted prices will represent the situation of the agricultural economy prior to March 1991 when credit and subsidies were still being provided. These cash flows are contrasted to the cash flows of the representative farm in the absence of government interventions. The removal of the distortions will correspond with the suspension of Banco Agrario credits and subsidies for the period following March 1991.

The accounting period used for the financial cash flow is of one year which includes a complete agricultural cycle and the farming off-season when other income-generating activities are practiced. The income from these other activities, however, are treated specially in the cash flows. The income generated from gold mining and selective logging (or wood extraction), the predominant activities during the off-season or dry season, are incorporated after the farm's net wealth has been determined in the absence of bank loans and additional sources of income. The object of this initial omission of the farm's other sources of income is to assess the economic viability of the representative farm both with and without this additional income.

To facilitate the completion of the cash flows, all the prices are estimated for the production of one hectare of upland rice. The small household farms of Madre de Dios will frequently cultivate a larger extension of land, perhaps 5-6 hectares including other products grown for household consumption. For purposes of the economic analyses, the cash flows for a single upland rice crop are limited to one hectare

and it is assumed that the farm experiences constant returns to scale. These restricted parameters are removed in the final discussion to portray a more realistic situation although the analysis will be largely unaffected.

The most significant variables or prices that are utilized to generate the cash flows of the representative farm are: crop yields or production, agricultural prices, labor, transportation, discount rates, and land.

1) Crop yields: Production

The value which is utilized for the average yield of upland rice expected from a newly cleared forest plot is 1500 kg (1.5 metric tons) per hectare, a production far below the average yields for other, more fertile regions of Peru or the world, both tropical and temperate (CIAT, 1990) (see Table 2). The rice varieties produced are upland varieties, the most important annual crop in the Amazon basin and the principal crop in Madre de Dios (INIAA, 1990 and Ministerio de Agricultura, 1991). Irrigated rice generally produces higher yields - 3.5 to 5.0 tons per hectare versus 1.5 to 2.5 tons per hectare than upland rice (Villachica, 1990).

Thus far, the upland rice farmers of Madre de Dios have not benefitted from the greater production yields of irrigated rice due to the lack of rural infrastructure and sources of power required to maintain an irrigation system. Also, the majority of farms in Madre de Dios are located on upland sites along the principal roads of the region and available sources of water for irrigation are scarce. Rainfall is abundant during the growing season, October through

March, but soil fertility is a significant constraint because chemical or other fertilizers are not applied and some of the rice succumbs to pests, diseases, and/or competition from weeds. Several older farmers in the area said that guano had been used as a fertilizer in the area 25 to 30 years earlier and yields had been greater, but the collapse of the Peruvian guano industry led to the abandonment of this source of fertilizer.

Other factors that contribute to the low productivity of the upland rice farms in Madre de Dios are the use of local (less well-adapted) seed varieties, low planting densities, and lack of control of plagues, pests, diseases. All these factors can be in part attributed to the lack of adequate agricultural technology and the need for farmers to rely solely on their own resources (INIAA, 1991).

For the purpose of these cash flows it is assumed that the entire production of rice is successfully sold to ECASA and the local market, although this is far from what actually occurs. Many farmers have failed to market up to 80% of their production due to reduced local demand for these products and inadequate storage facilities, among other reasons. Moreover, ECASA has suspended all purchases of rice as of the harvesting period in March and April 1991. The suspension of guaranteed sales to ECASA will be reflected by a 40% reduction of the rice production which is successfully sold (see Table 4b).

The rice farmers of Madre de Dios are presently obligated to sell their production in Puerto Maldonado to the households. None of the rice produced in Madre de Dios is exported to other regions of the country and the low prices controlled by the government have favored

the urban consumers in detriment to the rural producers, who have been receiving prices below the market value of their products.

2) Agricultural prices

The marked fluctuations of agricultural prices due to the varying price of foreign exchange and inflation can significantly alter the marketing and commercial potential of many agricultural products. This is especially the case in tropical forest regions such as Madre de Dios which are far removed from the large population centers and extra-regional markets.

Madre de Dios does not presently export any agricultural products to other regions of the country. In fact, of all the products that are being produced in Madre de Dios, only Brazil nuts, lumber, and gold are being transported to cities such as Cusco and Lima for sale or international export. For these reasons, agricultural prices are subject to the whims of the local economy and do not benefit from the relative stability, infrastructure, and more adequate markets which exist in many other agricultural regions of Peru (most notably the coast). Also, the government's price controls of agricultural foodstuffs which ensure affordable food for the urban consumers have kept the prices paid to the producers below the market value of these products. These price controls have, in essence, been a disincentive to production although other government mechanisms have been developed to increase the agricultural production. These contradictory policies, which support production increases and simultaneously keep the prices of these goods depressed, have further compromised the very risky and insecure economic state of the farms of Madre de Dios.

There has been a surplus production of agricultural goods in Madre de Dios in recent years which has far exceeded the demand for these goods in the local markets. This surplus, in addition to price controls, has caused the prices paid to farmers to be lower than the market value of equivalent goods in other regions of Peru.

The prices which are used for upland rice sales in the cash flows represent the average monthly prices as quoted by the Subregional government and the Instituto Nacional de Investigación Agraria y Agroindustrial (INIAA), both located in Puerto Maldonado.

3) Labor

The cost of labor is expressed as the average daily wage of a farm laborer (This wage is called a "jornal" in Peru which can be translated to "person-day", and the laborers are referred to as "jornaleros" or "peones"). In this instance, the labor provided by men and women will be given the same importance. Although the men assume responsibility for the more strenuous tasks such as clearing the land, the women and children do most of the work in the household and care for the secondary or subsistence crops. Therefore, although the literature may at times differentiate between the value of the labor provided by men, women and children, it will be assumed here that each member of the family unit contributes equally to the operation of the farm.

In Madre de Dios, the small family-run farms generally provide most of their own labor requirements. However, for some of the more labor intensive phases of the agricultural cycle such as the preparation of the land (including slash, burn and clearing of the

debris) and harvest some farmers depend on the help of neighbors. The offers of labor assistance are reciprocal and few exchanges of cash occur in these instances. The use of hired laborers generally depends on the availability of liquid capital or cash on hand. For many of the farmers in Madre de Dios, the capital requirements of paying laborers in cash are too great, especially during the final stages of the production process such as harvest.

4) Transport

The most significant costs affecting the small farms are the costs of transporting the products from the farm to the market. The farms along the two principal roads, Puerto Maldonado - Quincemil and Puerto Maldonado - Iberia, are located at varying distances from the principal market and thus experience different transport costs (see Table 4c). Agricultural products, as is the case with sawnwood and Brazil nuts, are generally transported by independent truckers (using small pickups) and the prices are determined by distance (km) or by the weight of the load (kg) (see Figure 1).

A sensitivity analysis has been carried out to study the effect of transport costs on the overall costs of the representative farms (see Table 4d and Figure 2). It is evident from interviews with farmers along the Puerto Maldonado - Quincemil road that beyond a certain distance from the market the farmers cannot afford to produce crops for commercial purposes because the transport costs become prohibitive.

5) The Discount Rate:

To ensure the proper allocation and use of capital over time an appropriate discount rate must be utilized for economic decision-making to properly reflect the cost to society of a given investment. The question of discount rates is a crucial factor in the context of a developing rural economy that must rely heavily on the exploitation of its natural resources. In general, "high discount rates lead to [unsustainable] exploitation of potentially renewable resources, while artificially low discount rates lead to investment in economically inviable projects and continuing the investment even when returns are poor" (Fearnside, 1984).

In Madre de Dios this problem of very low discount rates (negative real interest rates) has become exacerbated by the agricultural support programs which the government has for years implemented with objectives of colonizing and increasing the agricultural production in the region. For instance, subsidized interest rates and tax exemptions offered by the Banco Agrario and the government, respectively, have attracted settlers to make land-use decisions which would not be economically profitable in the absence of these supports. The discount rate must reflect the real economic cost of capital and the removal of artificial distortions would partly alleviate the problem of wasteful use of the region's tropical forests and other natural resources.

I suggest that the discount rate used to evaluate the economic condition of a representative farm in Madre de Dios should approximate the commercial lending interest rates (the opportunity cost of capital) now being utilized by the Banco Agrario, the most important

financial institution to the agricultural sector. (It has been estimated by the World Bank that the discount rate (the opportunity cost of capital) in most of Latin America is about 11%, and rates as high as 15% have been suggested as appropriate for Amazonian Brazil) (Skillings and Tcheyan, 1979).

In March 1991 the Banco Agrario was charging a real monthly subsidized interest rate of 8.6% to farmers in Madre de Dios depending on the terms and length of the loan. The real monthly commercial interest rate for the same period is 27.4%, a rate substantially higher than the subsidized rate. Due to an accounting period of only one year, discounting is unnecessary.

The financial decisions made by many of the Subregion's smaller farmers have been significantly affected by the "new" elevated opportunity cost of capital which is a result of the removal of several forms of agricultural subsidies and credits and the stabilization of the inflation rate which have occurred since September/October of 1990 (see Table 3).

6) Subsidized Loans

The loans obtained for upland rice from the Banco Agrario have been calculated from unpublished documents obtained from the bank and interviews with bank officials and farmers. The amounts used are the average loans to the smaller farmers of the upland sites along the roads, the most common locations and the most representative farming situations for Madre de Dios. These upland rice farms generally receive a sustenance or "sostenimiento" loan, payable over a period of two years. This type of loan is intended to satisfy the capital

two years. This type of loan is intended to satisfy the capital requirements of an agricultural activity in part or in full. The loans are intended for:

- The cultivation of annual crops, such as rice and maize, and the maintenance of permanent (or perennial) crops in production.
- The annual maintenance of cattle ranching operations.
- The extraction of forest products.
- The processing of agricultural products carried out by the producers and the storage requirements of these products.
- The provision of agricultural services, technical assistance, and applied agricultural research.

(own translation, Banco Agrario, 1985)

The "sostenimiento" loan from the Banco Agrario was the most common type of loan to individual farmers in Madre de Dios with approximately 1,302 rice farmers receiving the amount of I/m 381,178.83 (about US \$448,445 at .850 I/m per US \$ on June 30, 1991). This amounts to an average loan of approximately I/m 292.76 per individual farmer. These "sostenimiento" loans were distributed to the farmers in four installments, roughly corresponding with the agricultural cycle of the upland rice crop (see Appendix C). This amount of I/m 292.76 (or US \$343.53) per annum is used in the representative farm analysis and is contrasted with the prohibitive commercial loans in effect today.

Of course, the farmers do not utilize the entire amount of the loan on a single hectare of upland rice. Rather, the farmers of Madre de Dios frequently use some of these funds to purchase good for the household including, for example, clothing, school supplies, cooking utensils, and imported foodstuffs. It is therefore necessary to complete a sensitivity analysis to determine the amount of the loan

which must be dedicated to a hectare of rice to ensure the profitability of that production (see Table 4f).

7) Land

The value of land in Madre de Dios will be assumed to be negligible (or zero) because land is still today being distributed to concessionaires at very low costs to those colonists. The availability of "free" land in the lowland tropical forests of Madre de Dios is a very significant problem. Incentives to manage the land on a long-term basis do not exist and this negligible cost is another reason for the continued investments towards projects that deteriorate the forests' resources. It is more convenient to exploit an area of tropical forest and then simply apply for another concession of mature forest.

A system of land tenure which does not facilitate legal titling of the lands occupied by settlers will continue to hinder the possibility of developing sustainable, long-term management strategies. These alternative strategies could help ensure the proper maintenance of the Subregion's biological diversity and contribute to the attainment of higher living standards for the rural populace. The importance of secure land titles to the conservation of forest resources has been recognized by researchers for several years, but actions by the governments of developing countries have been slow to incorporate these policy recommendations:

"When villagers do not have secure title to their land, they have little incentive to make investments that would ensure sustainable use; credit is more difficult to obtain when tenure is insecure; and insecure tenure may bias the choice of crops over perennials, tree crops and forest plantations which tend to

be environmentally benign than annual field crops. Villagers [or colonists] lacking secure tenure are therefore forced to continue clearing new land, often destroying forest of high biological value and leaving little but wasteland behind." (Mc Neely, 1988)

There is an urgent need for the government to recognize the importance of secure property rights to the adequate functioning of the market forces which can contribute to the appropriate development of these forest lands. Aside from titling the land already placed into concessions, the local authorities would be well served to reduce the sizes of the concessions which are given to individual colonists because a small proportion of these large concessions are utilized efficiently. Also, many conflicts arise from competing land uses due to overlapping and poorly mapped concessions.

The Subregional government has recently created a judicial office in Puerto Maldonado for the settlement of all land-related conflicts and problems. This office or tribunal will also be responsible for the protection of the Subregion's natural resources as well as the indigenous flora and fauna (Sur, March 29 to April 4, 1991 and pers. obs.).

B) Results

The cash flows are constructed to reflect the different financial states of the representative farm assuming changes of some of the important variables which have been described in the previous section. Four different scenarios are analyzed (see Table 4b):

1) The farm's benefits (cash in) include the income from rice sales without credits or subsidies from the Banco Agrario. Only 60% of the rice is sold in this scenario.

2) The farm's benefits include the income from rice sales and the additional off-farm income from gold mining and wood extraction

3) The farm's benefits include the income from rice sales with the subsidized loans from the Banco Agrario and the guaranteed sale of the entire production to ECASA.

4) The farm's benefits include the rice and additional incomes with the subsidized loans and sale to ECASA of the entire production.

(Refer to Tables 4a through 4f and Figures 1 and 2)

The resulting Net Present Values (NPVs) present the financial well-being of a representative farm (at a distance of 25 km from the market) operating under the four different scenarios:

Scenario 1) Without any additional income or subsidized loans from the Banco Agrario, the upland rice farm has a negative annual Net Present value of US \$-206.87. This scenario is unprofitable.

Scenario 2) With additional income included, the farm has a positive NPV of US \$2191.06, due to the income from wood extraction (or gold mining). The extractive activities are therefore crucial to the economic viability of this farm in the absence of government intervention.

Scenario 3) With the subsidized loans, but no additional income, the farm does maintain a positive cash flow with a resulting NPV of US \$234.22. This is a small amount, but the loans are generally left unpaid because the real subsidized interest rates (accounting for inflation) have been highly negative which causes both the principal and interest payments to be insignificant.

Scenario 4) As would be expected, the representative farm had a high positive NPV of US \$2632.15 when the loans and the additional income were included. This scenario could represent the situation of the small farmers of Madre de Dios prior to the suspension of government incentive programs to agriculture.

Some variables, notably transport costs, distance from market, and loan amounts were manipulated to account for the variety of possible conditions which could prevail at the farms of Madre de Dios.

The sensitivity analysis for transport costs revealed that beyond a distance of about 38 km from the market, the farm will not be commercially profitable in scenarios 1, 2, and 3 (See Figure 2 and Table 4d). The cost of transport of both rice production and wood at this distance became prohibitive.

Table 4d). The cost of transport of both rice production and wood at this distance became prohibitive.

A sensitivity analysis for the Banco Agrario loan was also completed to determine the minimum amount of funds that the representative farm must receive in order to generate a positive Net Present Value (and thus be profitable). A farm at a distance of 25 km from the market must receive at least US \$120.00 from the bank to be profitable. The average "sostenimiento" loan to rice farmers during the last period of Banco Agrario disbursements between August 1990 and March 1991 was about US \$343.53, which would, of course, be utilized for a variety of purposes and a larger cultivated area.

Again, at increasing distances from the market, the cost of transport rises rapidly and thus the minimum required loan amount also increases sharply. The distance of 25 km was chosen at random, but represents a true situation for many of the Subregion's farmers.

C) Discussion

It becomes evident from this simple economic analysis of a representative farm in Madre de Dios that the agricultural sector has greatly depended on the government's incentive programs, particularly the subsidized loans and credits from the Banco Agrario and ECASA. ENCI has also supported the Subregion's farmers significantly, but this case study does not include the benefits derived from the activities of this agency. ECASA benefits rice farmers in particular and is thus more important in this specific instance.

The additional income derived from wood extraction and/or gold mining (or other extractive activities) is absolutely essential to the

economic well-being of the small settlers of the Subregion. In the absence of government support, the off-farm income represents a very substantial proportion of the farm's overall income. This analysis suggests that without government programs to subsidize and otherwise create incentives for the cultivation of commercial annual crops, the settlers would not choose to practice agriculture for commercial purposes.

Due to the recent suspension of agricultural incentive programs in many regions of Peru, the rural settlers no longer have any reason to continue farming commercial crops. Instead, other activities which are clearly more economically profitable such as wood extraction, gold mining, and the extraction of non-timber forest products, will become more attractive. Already in Madre de Dios, many farmers have expressed the fear that they will not be able to borrow money from the Banco Agrario at the newly set commercial interest rates. There are also indications that the Banco Agrario may cease all activity in the Subregion by mid-1992, but this development has yet to be confirmed (David Ricalde, pers. comm.).

Moreover, the failures of both ECASA and ENCI have further reduced the prospects of local farmers to successfully compete in the country's newly liberalized markets against goods from other more productive areas and less cost-burdened producers. The production of annual commercial crops, in light of the present constraints, is not economically or ecologically viable and the government should therefore abandon the promotion of these activities.

It is very likely that forest land use patterns in the Subregion, in the absence of government intervention, will experience a

transition from the conversion of forest lands for agriculture towards a greater emphasis on extractive activities.

Extractive activities and improved agricultural and forestry systems should concentrate on those products which can be profitably exported to other regions of the country. This is particularly important in Madre de Dios because there are a number of products indigenous to the area which can and must be promoted and sustainably exploited. These include wood, gold, perennial crops (such as citrics, cacao, coffee, achiote, fruits, nuts, oils, etc.), medicinal plants, and energy sources such as the natural gas of Camisea.

D) The Economic Risk in Agriculture and Farmers' Land Use Decisions

Economic risk or uncertainty are inherent to any agricultural project and affect significantly the agricultural economy of Madre de Dios. The representative farms which have been analyzed can be viewed as individual agricultural projects. Also, the collection of government incentive programs which have been implemented in the Subregion are also a kind of agricultural project. Both these types of projects are deeply affected by the unpredictable factors which can influence the success (or failure) of agricultural activities such as local demand for the products, good or bad weather, soil conditions, relative price distortions, competing land uses, tenurial rights on the land, and a host of other economic and environmental variables.

The perception of a high level of risk of investing in agricultural projects may be even greater due to the unique ecological and climatic conditions that characterize lowland tropical forests. This perception of risk may in part explain the very limited amount of agricultural development of tropical forest lands prior to the creation of government credit and subsidy programs which have recently attracted the private sector to invest in this region. The government has thus financed projects that the private sector would consider too risky and uncertain. The financing made available by the government has distorted the true costs of agricultural production and created an artificial illusion of economic profitability. This has been an illusion because, although the private sector has benefitted from the government's largesse, society has incurred great financial losses and no real economic dividend has resulted for the rural settlers of Madre de Dios.

At the root of the problem are two important considerations: First, the Peruvian government has, over the past several decades, grossly miscalculated and/or underestimated the risks of investing in agricultural incentive programs in tropical forest regions.

Second, Peru's economy is not highly diversified. The great amounts of government investment and intervention in agricultural settlement, credit, and subsidy programs (with reliance on successful agricultural production and the growth of that sector) have created a huge financial burden for the country. In addition, these continual public investments in colonization and forest conversion schemes have created a dependency by the rural settlers on these misguided and irrational incentive programs.

Thus, an analysis of the agricultural economy of Madre de Dios must involve the realization that the very high risks of investing in agriculture in these forested areas may doom the outcome of these public projects from the start. In fact, the objectives of financing the settlement of the lowland tropical forests of Madre de Dios should most likely not be based on the economic profitability of such ventures. The more rational objectives of settling the isolated border regions of the country are to secure these relatively uninhabited regions as a matter of national security and to relieve population and land pressures in the Andean regions. On economic merit alone, the agricultural development of Madre de Dios is an economically unviable undertaking.

The conservation of the tropical forests should thus be justified as an economically sound policy in view of the failures of agricultural projects and ineffective land use policies that have been

heavily promoted by the government for decades. In the words of one prominent economist:

"Although such policies have been adopted in the name of development, the issue is not between economic development and resource conservation. Most are unsuccessful when judged only as a means to promote economic growth. They result in huge economic losses: wastage of resources, excessive costs, reductions in potential profits and net foreign exchange earnings, loss of badly needed government revenues, and unearned windfalls for a few favored businesses and individuals.

[Moreover], they also result in severe environmental losses: unnecessary destruction and depletion of valuable forest resources; displacement of indigenous peoples, degradation of soils, waters, and ecosystems; and loss of habitat for many wildlife species." (Repetto, 1988)

Fortunately, Madre de Dios has not lost a very significant amount of its tropical forests and time still remains to adopt the policy improvements which exist presently to achieve the dual goals of sustained rural development and tropical forest conservation. Several possible policy changes and reforms are discussed in the concluding sections of this report. An attempt has been made to specify those policies which would have the greatest possibility of success in Madre de Dios. These results should not be interpreted to be a set of policy guidelines for all lowland tropical forest areas. Although many tropical forests may have similar physical attributes, the economic and political characteristics of a region will largely determine the adequacy and appropriateness of land use policies for that particular area.

The preceding economic analyses of a representative upland rice farm in the lowland forests of Madre de Dios has been completed to emphasize the important inter-relationships between economic, environmental, and political factors which must be considered in concert when evaluating the purpose and consequences of development

schemes for the lowland tropical areas of any country. In addition, it has become extremely important for resource economists to quantify the effects of inadequate, and all too often destructive policies of forest land use in tropical developing countries. These numbers support the cause of conserving valuable natural resources because many politicians and development entities in these countries need to become aware of the financial and environmental losses that result from incorrect policies. The arguments against the poorly designed and inefficient policies which have been implemented in Madre de Dios should further the transition to reforming the planning process and achieving more sustained mechanisms of rural development for this Subregion of southeastern Peru.

IV. Forestry in Madre de Dios

In Madre de Dios the principal method of forestry is selective logging, whereby the mature individuals of several valuable tree species are extracted and the remainder of the species are left unutilized. This activity is widespread throughout the region and most of the settlers are involved in the extraction of wood in some form or other. The most common type of logging interests are small individual settlers working on concessions obtained through the Ministry of Agriculture. These concessionaires have limited capital and machinery which has restricted the growth of this sector substantially. Also, these small informal loggers do not have the political clout to effectively lobby the government for support of the industry. The relative lack of formal support from the public sector to forestry stems partly from the inability of the government to benefit financially from wood extraction and the failure to monitor these activities throughout the Subregion.

A) Characteristics of the Forestry Activities in Madre de Dios

Madre de Dios and other areas of the Upper Amazon basin in Peru, unlike other tropical regions of the world such as parts of S.E. Asia and Brazil, have been spared the widespread depletion of valuable tree species by loggers due to several factors that have thus far inhibited the development of forestry. In fact, recent data and observations have detected a decrease in the rates of forest conversion as forestry and agriculture have become less profitable since about 1987. This

trend correlates well with the beginning of a period of dramatic increases in the nation's inflation rates and the relative price distortions of many important commodities. (see Tables 5 and 6)

This situation has come about due to a variety of factors including the following: 1) There are very few roads or other modes of access to the forests' interior; 2) Most of the region's settlers do not have the capital or machinery required to undertake large logging operations; 3) The region suffers from a lack of the infrastructural development that would enable logging practices to become modernized and transportation within Madre de Dios is very costly; 4) Very few tree species are of commercial value, local markets are inadequate, and wood prices are depressed due to limited markets and monopolistic behavior among the local buyers; And, 5) The government has provided few incentives which would promote management and/or appropriate exploitation of the tropical forests for wood.

1) Access to the Forests

The extraction or "mining" of wood virtually free of charge has attracted settlers to this region since the area was first colonized during the rubber boom of approximately the years 1894 to 1919. The political creation of Madre de Dios, the establishment of the present borders with Brazil and Bolivia in southeastern Peru, the increasing migrations to Madre de Dios, and the development of the area's principal channels of transportation and communication can all be traced back to this important period of rubber exploitation (Subregion Madre de Dios, 1991). The commercial exploitation of wood in Madre de Dios began in 1962 with the building of the road that connects Puerto

Maldonado with Cusco, one of the principal cities and commercial centers in southern Peru. Prior to 1962 the extraction of wood in Madre de Dios was carried out solely to supply local construction and infrastructural development.

The extraction of the larger individuals of valuable tree species (a practice known as highgrading) takes place principally along the two main roads in the subregion, Puerto Maldonado - Quincemil and Puerto Maldonado-Iberia, and along the major navigable rivers which include the Madre de Dios, Las Piedras, and Colorado rivers, and to a lesser extent the Tambopata river (see Appendix A).

Settlers in Madre de Dios do not have many points of access into the mature tropical forests and loggers are forced to build small logging roads to reach the larger, more valuable trees. The majority of the settlers in Madre de Dios live on either side of the principle roads, rarely entering more than 5-6 km into the forests from these roads (Frank Cruz Sisniegas, director of IIAP, pers. comm.). The areas contained within this 5-km strip of land have been extensively logged and farmed. These areas should be the sites intensive forestry and agricultural production. Also, some of the region's main rivers have become more important to loggers as the volumes of commercial species along the roads have decreased.

The Madre de Dios river is the principal river system in the Subregion and has been the site of most of the human activity in this part of Peru since the first settlers arrived with the rubber trade and in search of gold. The amount of wood which has been extracted along this river is difficult to estimate due to the absence of accurate records (concession maps are unclear and production estimates

are vague approximations) and the informal nature of this activity. The larger logging enterprises in Madre de Dios are located along the Madre de Dios river to ensure easier access to Puerto Maldonado, the region's most important market as well as the location of the best port facilities. The logs that have been felled and allowed to dry during the dry season (April/May through September) are transported by the river from the upstream logging concessions to Puerto Maldonado where the logs are further cut and sold to professional buyers or middlemen who represent local industries or firms from some of the country's larger cities. The few large logging concessionaires in Madre de Dios do manage to export sawnwood to Lima and Cusco, but these businesses represent a small proportion of the loggers in Madre de Dios. The vast majority of loggers are forced to sell their wood at the low prices paid at the Puerto Maldonado port.

The Las Piedras river has recently become a favored location for logging activities due to the availability of large valuable trees which have become quite rare in other more accessible areas of the region. However, the extent of human occupation along the Las Piedras river is minimal and loggers enter this river primarily to extract the larger individuals of Swietenia macrophylla and Cedrela odorata (known locally as Caoba and Cedro, respectively), the two species which are commercially viable at such distances from the markets at Puerto Maldonado or Laberinto (see Appendix A).

The other rivers such as the Tambopata and Colorado rivers have been exploited in the past and the amount of logging along these and other rivers is not very significant. Indeed, many loggers have stated that they rarely enter the forest to distances exceeding 2 km.

stated that they rarely enter the forest to distances exceeding 2 km. Also, as a general rule, as the distance from the markets increases, the densities of colonists in any given area decreases and thus the exploitation of the forests is also reduced. This situation has some interesting ramifications. The reduced pressure on the mature forest has resulted in a concomitant decrease of negative impacts on the biological diversity of the Subregion, at the expense of economic expansion and rural development.

2) Low Levels of Technology, Mechanization, and Capital Assets

The forestry and agriculture sectors of Madre de Dios both suffer from the limited availability of technology and mechanization that would permit a more intensive exploitation of the forests resources and an increase in the productive potential of this region. Also, the loggers of Madre de Dios have very limited access to any sources of capital or the services of financial institutions. This is primarily due to the relative absence of credit from the Banco Agrario for logging in relation to other more highly subsidized activities such as agriculture and cattle ranching. Also, the interest rates that are being charged by the commercial banks, and now by the Banco Agrario as well, have made loans prohibitive to many smaller colonists.

The majority of the logging operations do not have access to the technology or machinery required to implement intensive forest management techniques. The loggers with small to medium size concessions (less than 2,000 ha) generally fell the more valuable trees with chainsaws and then prepare the trunks on site for transport by removing the branches, crowns, and other less valuable parts of the

area are left unexploited and much of the wood is wasted which could otherwise be marketed. In some cases, small gasoline-powered portable sawmills are used, but there are few of these machines. There are no pulp or paper mills in Madre de Dios and an insignificant amount of the sawnwood is processed further. Thus, value added to the forestry products is very low. Adding value to the sawnwood produced in the Subregion is one method of increasing incomes generated by this activity which should be promoted.

This system of selective logging or highgrading is very inefficient because much of the wood from a particular tree is left unutilized. The loggers must ensure that only the very best parts of the tree are transported to the markets due to the elevated costs of transport and the particular demands of the market. Most of the loggers in Madre de Dios do not own the vehicles necessary to transport the wood with the notable exception of the few very large logging operations. In many cases, due to the lack of transport vehicles in the region, a logger will sell the wood on site to a middleman or to the larger logging operations who will then transport the wood to be processed at sawmills closer to market (generally Puerto Maldonado). Of course, the prices at the felling site are reduced because the buyers must incur the high costs of transport and processing.

Another serious constraint to the further development of the forestry activities is the virtual absence of government support and financing of this sector. In its present state and considering the recent policy reforms that have been implemented by the Fujimori administration, forestry in Madre de Dios is unlikely to benefit from

been implemented by the Fujimori administration, forestry in Madre de Dios is unlikely to benefit from public investment. Moreover, this sector is not likely to become modernized and incorporate more efficient forest management techniques such as natural forest management, plantations, or agroforestry. For these more technologically intensive management strategies to be possible in Madre de Dios there needs to be much greater public investment in securing the information and extension services that would facilitate a transfer of knowledge to the area's settlers.

In addition, the government must address the problem of the inadequate transportation facilities that exist within the Subregion. This problem which will continue to inhibit the further development of the rural and urban economies must be resolved. However, the very elevated costs of building all weather roads and permanent bridges in these zones of lowland tropical forests will prevent the solution of this most important problem.

There exists an enormous potential for growth in the forestry sector, particularly on the large extensions of "purma" (the abandoned agricultural and pasture lands that remain unused as shrubland or secondary forests) and the appropriate management of these areas would remove some of the pressure on the mature forests. In addition, until legal land titling replaces the present absurd and inefficient system of concessions, the settlers will not have any incentive to assure the medium or long-term management of the forest resources. The loggers who were interviewed expressed a willingness to cooperate with efforts to modernize the processes of wood extraction and realized the need for reforestation programs. However, the lack of technology, capital,

and extension services (in addition to the limited commercial potential of this activity) have brought the further development of this industry to a virtual stand-still.

To ensure the proper use of forest resources it is very important that the government place more emphasis and efforts into the management systems that will make more intensive use of the forest lands that have already been exploited.

3) Lack of Infrastructure and Elevated Transportation Costs

The lack of adequate infrastructural development is the overriding problem that has prevented the economic and social development of the Subregion. This problem is of particular importance to agriculture and the region's extractive activities which include selective logging, Brazil nut collection, and rubber-tapping. These activities are generally dispersed throughout the more rural areas of Madre de Dios and thus have a greater dependency on the transport, storage, and other services that the government has traditionally provided for these more economically depressed areas.

The elevated costs of transportation are in large measure attributable to the very poor condition of the roads in Madre de Dios. There are no paved roads in the region and many of the transport routes are virtually impassable during the rainy months of the year (roughly October to April/May). Some of the roads such as the very important route between Puerto Maldonado and Cusco are considered so problematic and dangerous by the truckers that the transport costs are automatically multiplied. For example, the 531.8 km from Cusco to Puerto Maldonado is multiplied by a factor of 2.9 so the distance

charged is of 1542.2 km, a significantly greater distance. And, the multipliers for potentially volatile or dangerous products such as gasoline or petrol are 3.1 and 3.6, respectively (Subregion Madre de Dios, 1991). The terrestrial freight or transport costs for timber in Madre de Dios are the following for May 1991:

Origin and destination	Freight ----(I/m per board foot)----	Prices (Caoba)
Puerto Maldonado/Cusco	.18	.25
Puerto Maldonado/Juliaca	.23	.25
Puerto Maldonado/Arequipa	.25	.25
Puerto Maldonado/Tacna	.29	.25
Puerto Maldonado/Lima	.30	.25

(Adapted from Dirección Forestal y Fauna, Ministerio de Agricultura, Puerto Maldonado, May 1991)

The cost of transport can, in some cases, exceed the prices paid for the wood in Puerto Maldonado, which helps explain the low prices that the buyers are willing to pay for these products since the buyers or middlemen will incur the costs of transport.

Some of the wooden bridges that cross the numerous streams and secondary rivers in the region are also seasonally damaged by flooding and the weight of the trucks which carry merchandise to and from Cusco and other regions of southern Peru. Also, there are no bridges crossing the principal rivers of the Subregion which has further restricted terrestrial transportation. There is a plan to build a bridge (to be called the Puente Bolognesi) over the Madre de Dios river at the port facilities near the confluence with the Tambopata river, but financing has not been secured and the engineering requirements are quite complicated due to unstable river banks (which are in a state of constant change due to the river meandering).

Thus far, the government has been concentrating much of the annual budgets for public works into making temporary repairs to these roads and any hopes of constructing more permanent transportation facilities, as mentioned above, do not seem very realistic for the near future.

4) Few Marketable Species and Depressed Prices

The commercial exploitation of a relatively low number of tree species is another problem that has been identified by researchers, extension agencies, and local loggers alike. As in many other areas of the tropics, very few tree species of commercial potential are exploited in Madre de Dios. This has led to a very inefficient use of the forests' wood and non-wood resources because a large amount of forest is disturbed to extract several choice species of locally recognized timber value. Also, the loggers are forced to travel increasing distances to search for the valuable species while disregarding many tree species that have been identified as of commercial potential. The market acceptance of a larger proportion of tree species and higher prices for secondary species would lead to a more intensive use of the areas that are presently being exploited by logging. Also, a better knowledge of the potential uses of the great variety of tree species and more research of the floristic composition of these forests could yield some positive results and increase the quantity of alternative management options. Another factor that could improve this situation is an increase in the prices that are paid for wood within Madre de Dios.

In Madre de Dios the tree species that are considered of greatest value by the local logging interests are the well-known hardwoods such as Caoba (Swietenia macrophylla), Cedro (Cedrela odorata), Tornillo (Cedrelinga cataeniformis), and Ishpingo (Jacaranda copaia). There are several other species of intermediate value that comprise a very small percentage of the total wood extracted which include Moena (Aniba spp.), Cumala (Iryanthera dialyanthera and I. otoba, Virola spp.), Pashaco (Schizolobium amazonicum), Lupuna (Chorisia insignis), Lagarto Caspi (Colophyllum brasiliensis), and Catahua (Hura crepitans) to name but a few (see Appendix C). Many species which may be important to the more intensive exploitation of certain areas are virtually unknown to loggers and some species have not even been identified by science. For instance, since the mid-1980s, 28 species of Lauraceae (an important timber family) have been described which were previously unidentified (Gentry, 1992).

According to Ministry of Agriculture figures published by the local government, the volume of wood (sawnwood) production in Madre de Dios increased from 14,933 m³ in 1980 to 20,295.83 m³ in 1990 which represents an very modest growth for the period. But, the volume of wood produced has been decreasing since 1987 when production peaked at 34,616.04 m³ (see Table 5).

Many local loggers have expressed a common frustration at the increasing difficulty of accessing the areas of mature unexploited forests that contain large individuals of the more valuable species. These loggers have also noticed a scarcity of the valuable species that have been high-graded for many consecutive years. Today, Swietenia macrophylla (Caoba) and Cedrelinga cataeniformis (Tornillo)

are considered locally rare and there is the danger that these species may soon be completely removed from certain zones as increasingly smaller individuals are extracted.

Another trend in the forestry sector which has caused recent consternation in the logging community is the diminishing number of species which can be extracted for any economic profit due to the escalating costs of extraction and transport and the low prices of these woods at the markets. In the month of August 1991, only the three most valuable tree species were still being sold at the ports and other market locations in Puerto Maldonado with any success (pers. obs.). However, the prices of wood in Puerto Maldonado are established by a consortium of buyers who agree on very low prices because the loggers generally do not have the political or legal clout to challenge the buyers.

Some loggers at the ports of Puerto Maldonado said that the prices being paid for the wood will barely cover the costs of extraction and transport from the forest sites (see Table 4c). Even the owner of one of the largest logging operations in Madre de Dios recognized that the sale of wood at the local markets is not economically viable and stated that his business is not profitable until the products are converted into finished products in Lima (pers. comm.). However, the loggers are not in a position to refuse even the low prices offered at the principal markets because a competitive market for these products does not exist in the Subregion and there are no alternatives but to sell the wood at the prices offered. It is not uncommon for a buyer to set a price and then simply wait until the loggers feel forced to sell the wood or risk losing the sale. Several possible reforms of

the pricing systems for forestry and agricultural products are outlined in subsequent sections of this report.

Other reasons for the need to sell the wood promptly are the lack of storage facilities and the possibility that the wood could quickly begin deteriorating due to rain, sunlight, and other climatic factors.

5) Few Government Incentives to Forestry

In the past few years there has been a diminishing effort by the public sector to increase the production of wood in Madre de Dios. This activity has had to compete for limited funding and credits with other land uses, notably agriculture and cattle ranching. The government has favored these other land uses partly because selective logging is a very difficult activity to monitor and the benefits are not captured by the local government. In addition to limited direct investments in the forestry sector, the government has not placed much emphasis in the development of adequate reforestation, extension, and natural forest management strategies that could dramatically alter the character and efficiency of the forestry sector.

The Ministry of Agriculture, INADE (The National Institute of Development), and INIAA have all claimed to have reforestation programs, but the actual level of reforestation in Madre de Dios is minimal. The area of reforested land in Madre de Dios amounted to only 27 ha in 1990 by official estimates, but subsequent management of the planted seedlings is absent and the majority of these seedlings die soon after being planted (INE, 1991). These government entities have attempted to develop nursery facilities to reforest exploited lands with Brazil nut (Bertholetia excelsa), rubber (Hevea

brasiliensis), and Caoba (Swietenia macrophylla). The programs have failed for several reasons. There is no incentive to reforest because the land is held in temporary concessions and the benefits from reforestation will not accrue until about 40 years after planting for the timber species. Also, the colonists are not trained in the appropriate techniques of planting the trees and frequently disregard the seedlings or plant them in a crowded and careless fashion. Lastly, the government agencies do not have adequate nursery facilities or the technical personnel to undertake a comprehensive reforestation program.

The problems that have been inhibiting the adequate management of the forests of Madre de Dios for wood production are symptoms of the overall depressed economic and social conditions that characterize Madre de Dios. It is very likely that further development of both the forestry and agricultural sectors will experience greater difficulties in the near future. However, there exists in Madre de Dios an enormous potential for growth and adoption of appropriate management plans for the tropical forests. The following sections will focus on the efforts of some of the local institutions to correct some of the problems which have been identified and other management alternatives will be discussed that could potentially create a more sustained development of the forests' resources. These alternative land use strategies include intensive plantation forestry on marginal lands, agroforestry, and low-input cropping techniques to ensure continuous cultivation of agricultural lands, as well as other alternative land uses.

B) Local Decision-making Entities:

1) The Ministry of Agriculture: Agriculture and Forestry

The Ministry of Agriculture is responsible for the administration of the logging and agricultural concessions which are distributed to settlers throughout the Subregion. The Ministry is also responsible for setting production levels for crops and wood and are supposed to ensure that the forests' resources are managed appropriately by the settlers. The Ministry of Agriculture is also the principal governmental entity overseeing cattle ranching in Madre de Dios, but this activity is not within the scope of this report.

Land Tenure and Concessions: A Conflict of Interests

The process of obtaining a permit to extract wood is similar to that for agricultural activities. Typically, the applicant will seek permission to selectively log an area that he/she has previously identified as being of commercial value. The criteria for valuable forestry land is the presence of the most valuable tree species on the local and national markets, Cedro (Cedrela odorata), Caoba (Swietenia macrophylla), and to a lesser extent Tornillo (Cedrelinga cataeniformis). The Ministry then decides on the volume of wood that each applicant must produce in accordance with the size and duration of the concession. In most cases, the applicants obtain the land that they have requested easily because the Ministry's principal objective is, in effect, to extend the area of "productive" or cleared land in the Subregion.

The concession program is inefficient and ineffective. The Ministry of Agriculture and the local government are not capable of keeping track of how much forest land is being utilized. This would help to determine where the settlers are located and to monitor the manner in which forest lands are being exploited.

After an applicant has obtained the required permits he/she is essentially free to go and will probably not be held accountable for the production requirements which have been established or the type of land use for which the concession has been intended. Through many interviews with local loggers it is evident that the people understand the limitations faced by the Ministry of Agriculture. The most important problems affecting the effectiveness of the Ministry are a lack of adequate funding, a dearth of information about the resources of the region, minimal technical extension personnel, lack of mobility and materials, and unclear policy objectives.

a) Inadequate Funding

The problem of inadequate funding to finance the salaries and projects stems from an overall lack of government funds at the regional and national levels which has been caused by the need for the government to curb expenditures in the public sector. These spending cuts are particularly evident in the more isolated areas of the country and the economic sectors which have traditionally benefitted from important credits and subsidies such as agriculture. The suspension of support programs from the Banco Agrario, ECASA, and ENCI, agricultural production will most likely decrease dramatically in the immediate future and many land use practices in Madre de Dios

may become increasingly informal in nature. These possibilities will complicate the work of the Ministry of Agriculture as the patterns of settlement and the activities of the colonists could become very difficult to monitor and coordinate. Without some important land tenure and land use reforms, the Ministry's lack of adequate funds will become a more serious problem than it already is.

b) Lack of Basic Information about the Forests' Resources

The Ministry of Agriculture suffers from the same lack of basic information about the forests' resources and ecological constraints that affect many other public and private entities which are trying to develop these tropical lands. There is an urgent need for scientific research on matters such as hydrological processes and watershed management, soils, natural forest management, tropical forests' species diversity and the potential commercial uses of many of these species of plants and animals, human carrying capacity of these ecosystems, and other issues that will contribute greatly to the more appropriate management of these forests.

The Ministry of Agriculture does not at present have access to any updated information about the natural resources of Madre de Dios, although some useful studies do exist. The activities of the Ministry are focused on continuing the same basic programs of facilitating land settlement and increasing agricultural production which have been in place for a number of years, although these programs have not resulted in any significant betterment of the living standards of the region's inhabitants or the sustained use of the forests. The incorporation of the multitude of studies of sustained tropical land uses that have

been carried out throughout the neotropics, which are readily available, could help the Ministry of Agriculture redirect its efforts towards management strategies that are better adapted to the region's ecological characteristics.

c) Few Adequately Trained Technical Personnel

A third problem that was emphasized by the Ministry's directors was the lack of well-trained technical personnel which could instruct the region's farmers about important technological advances in soil conservation, reforestation, agroforestry systems, crop management and improvement, and other land use improvements. The Subregion's settlers are fully aware of the need to ensure the conservation of the tropical forests for future generations, but these same settlers are very frustrated by the lack of extension services and government programs which could distribute these technologies. In 1991, due to a lack of funds to pay a full staff, the Ministry of Agriculture was forced to lay off some "non-essential" personnel. Regretfully, the majority of those that were dismissed were technicians.

The office of marketing of agricultural products within the Ministry of Agriculture is also deficient. This office is responsible for providing the area's settlers with access to adequate markets, assuring fair prices for agricultural products, and promoting the commercial development of agriculture. INIAA had been responsible for these issues (when this agency was called INIPA), but all promotional tasks were transferred to the Ministry of Agriculture which is failing to provided these services.

The Ministry also has an office of soil conservation which is not operational due to limited financial and human resources and the low priority assigned to these activities.

d) Limited Mobility and Materials

The limited mobility and lack of sufficient materials have also hampered the work of the Ministry of Agriculture. The ministry does not have the vehicles necessary to travel to many of the concessions to perform on-site inspections. These inspections would help the Ministry monitor the extent of land that is being worked by the loggers and verify the production claims made by the concessionaires. The Ministry had only two motorcycles in operation as of August 1991 and these vehicles were being used by the employees of the Ministry for personal uses not related with the work of the Ministry. The only large vehicles that were operational were one small pickup truck and a van which INIAA (the National Institute for Agricultural and Agroindustrial Research) had obtained with money from USAID. However, these vehicles were being used on a daily basis by INIAA and were not available to the Ministry of Agriculture although the two agencies are located in the same compound. Aside from the very limited availability of motor vehicles, the rising costs of gasoline and motor oil have severely limited the use of these vehicles.

2) The National Institute of Development: INADE and the Proyecto Especial Madre de Dios

INADE has been carrying out several projects aimed at developing the physical and social infrastructure of Madre de Dios. The projects are being financed by the Peruvian Government and the 1992 budget totals about US \$10 million.

Some of the principal activities of the Proyecto Especial Madre de Dios to date include the maintenance of the road from Iberia to Puerto Maldonado, the planting of rubber (Hevea brasiliensis) seedlings in several locations throughout the northeastern portion of Madre de Dios (the research station is located at "Noaya", about 37 km. from Iberia), the electrification of several towns in the Tahuamanu province, the development of health and education programs, and the establishment of "transborder" relations with Brazil and Bolivia to facilitate cooperation and commerce (Mi Frontera, no. 2, 1992 and pers. obs.)

The project has been criticized for fraudulent use of the very substantial amount of funds which it has received (in US \$) and the results of this investment have thus far remained far below the expectations of both the public and private sectors. Those aspects of the projects which pertain to natural resource management, such as the development of rubber and Brazil nut (Bertholetia excelsa) nurseries, have failed to account for the ecological constraints of the Sub-region and lack the technically capable personnel necessary to successfully develop the nurseries.

INADE should be held accountable to the people of Madre de Dios for the exact uses of the funds which have been provided. Moreover,

the Proyecto Especial should be administered by local non-elected authorities (to avoid political conflicts) and more emphasis should be placed on resolving the problems associated with dispersed settlements, rural credit, and conflicting land uses.

3) The Association of Extractive Foresters

The Association of Extractive Foresters in Puerto Maldonado is an organization that represents the interests of the loggers of Madre de Dios. The principal activities of this group consist of lobbying the local government for support of the Subregion's forestry activities and collecting a reforestation tax that presumably goes towards replacing some of the trees which have been extracted.

In an interview with the president of the Association of Extractive Foresters in Puerto Maldonado several important concerns were discussed. The Association expressed a dissatisfaction with the lack of help that local foresters have been receiving from the government. The government's active participation in support of the logging interests has diminished since 1987. These concerns include, most importantly, a difficulty in obtaining advantageous loans and credits from the Agrarian Bank.

The Agrarian Bank does not emphasize loans to forestry because these activities are of an informal nature for the most part. Of course, a few large logging operations in the Subregion do have the capital and equipment requirements necessary to conduct business without having to rely on favorable loans or credits from the Agrarian Bank. The small or independent loggers, however, cannot continue to extract wood without the loans and credit programs that were available until recently. With the surge in the prices of virtually all the primary commodities including those of gasoline and kerosene, the cost of extraction and transport of the wood has become prohibitive.

The president of the Association of Extractive Foresters also expressed the need for a forestry technician to work in Madre de Dios

and help address some of the problems that the industry is facing. He realized the urgency of developing a comprehensive plan for the management of the forests and resolve the problem of increasing scarcity and practical difficulties of locating and extracting the more valuable tree species. Such a management plan could also include measures to bring an end to the conflicts that have become commonplace between competing land uses.

Also, a forestry technician with the appropriate training could help local loggers successfully market their products and initiate a reforestation program.

V. Gold Mining

Gold mining is the main economic activity in Madre de Dios and may support up to 80-90% of the sub-region's economic production of goods and services (pers. comms.). However, accurate data regarding the extent of gold being extracted from Madre de Dios is almost impossible to obtain for several reasons. Firstly, the Banco Minero del Peru in Puerto Maldonado has experienced "a systematic financial collapse since about 1989 which diminished the percentage of extracted gold the bank could purchase (Banco Central de Reserva del Peru, 1991). Secondly, much of the gold is being extracted by seasonal miners who come from the nearby highlands, especially Puno and Cusco, and the number of such miners is difficult to monitor. Thirdly, the prices that are being paid per gram of gold in Brazil are greater than those being paid to the miners by either the banks or the local black market, so a lot of the gold has been smuggled illegally into Brazil. In addition, the world price of gold fluctuates quite violently and the production of gold in Madre de Dios has been closely related to these price changes (See Table 7).

A) The Financial Collapse of the Banco Minero

For many years the mining operations sold the extracted gold to the Banco Minero because the bank guaranteed prompt payment to the miners. This was a relatively simple transaction and the Banco Minero generally had the liquidity required to purchase a large portion of the gold being produced. However, since the period of rapidly rising inflation rates during the years 1986 to 1990, the bank began to

experience a shortage of the cash necessary to make these purchases. This situation parallels the problems faced by the Banco Agrario.

B) Seasonal Migrations of Gold Miners from the Highlands

The gold of Madre de Dios is a major source of income for the people of some of the highland communities in Puno and Cusco which are located to the South and West of the Sub-region of Madre de Dios. The number of seasonal miners who arrive to Madre de Dios from these areas probably approximates 15,000-20,000 per year. The majority of these miners are young men who travel to Madre de Dios during the rainy season after having prepared the agricultural fields at their respective highland communities (Bullard, 1990). Some of these people arrive with their families and proceed to settle permanently in Madre de Dios, but the exact rate of immigration from this source is unknown.

C) Fluctuating Gold Prices and the Trade with Brazil

It is very difficult to estimate the exact amount of gold that is being smuggled to Brazil or the amount which is being sold locally due partly to the lack of any transaction records. In addition, some of the gold extracted in Madre de Dios is being transported to other cities such as Lima and Cusco and being sold there either as a raw or finished product. Another figure that is difficult to estimate with any accuracy is the number of people that are actively involved in the search for gold in this area. An official of the Banco Minero in Puerto Maldonado has expressed the belief that there are between 10,000 and 15,000 gold mining foremen in the Sub-region with 4 to 6

workers each. This would indicate that there are between 40,000 and 90,000 people involved in gold mining in Madre de Dios. These numbers can exceed the official population estimates of approximately 50,000 for Madre de Dios. From interviews and conversations with many local inhabitants it was evident that virtually every family in this region obtains some percentage of their income from mining to supplement the income derived from their more formal agricultural or forestry activities.

According to officials of the Banco Minero approximately 500 kg of gold per month are being extracted from the rivers of Madre de Dios. This figure is quite large considering that the official production in 1982 (the gold bought by the Banco Minero) was 1,900 kg (Dourojeanni, 1990). Since the late 1950s, gold has been an important source of revenue for the people of Madre de Dios and neighboring regions (most importantly Cusco and Puno) and much of the gold available in the more accessible areas has been mined for some time.

During the years 1972-1980 this region of the country experienced a gold rush due to the increasing world price for gold and many settlers have since migrated to the area with dreams of striking it rich. However, there is evidence that the average amounts of which that are being extracted from the rivers have been decreasing for several years (pers. comms.). For instance, independent miners who pan for gold along the edges of the rivers have experienced a drop in daily extraction from 3-5 grams of gold per person to 1-3 grams since the mid-1980s. Also, the more larger mining operations which use dredges have also experienced diminishing production and express the

common view that new sources of gold must be found if the industry is to continue expanding and supporting local economy.

Some of the areas which local miners consider very promising are the upper sections of the Tambopata and the Candamo rivers. Much of these areas are located within the Tambopata-Candamo Reserved Zone. This protected zone could be negatively affected by gold mining because hunting by the miners and the use of mercury (which is lost into the rivers and atmosphere at alarming rates) would deteriorate the ecological integrity of the tropical forests in these watersheds.

Gold mining must thus be more closely regulated and the government needs to clarify the property rights which are assigned to gold miners. Also, the local government should develop some mechanism to tax this activity which could contribute substantially to the public treasury. This activity is very profitable relative to the other principal land uses of the Subregion and the public sector should benefit from the exploitation of this valuable mineral.

The following sections will discuss the government incentive programs that drove the migrations of Peruvian settlers to the lowland forests of Madre de Dios and the consequences of those policies.

VI. Incentives, Disincentives, and the Colonization of Madre de Dios

A) Settlement Policy and the Peruvian Economy

The government of Peru created a variety of fiscal and economic incentives for settlers to populate the isolated tropical forest regions of the country in efforts to colonize and promote the development of these areas. In addition, worsening socioeconomic conditions and political violence are also driving settlers from other regions of the country to the tropical forests of southeastern Peru.

The most attractive incentives include agricultural credits, low-interest loans, tax exemptions, price supports, and a perverse land tenure system. Also, demographic pressures and competition for land in the Andean highlands have forced many to seek new lands in the tropical forests to the east. The heightened violence of the terrorist groups, especially the much feared Sendero Luminoso (Shining Path), and the increasingly dangerous cocaine production and trade within the northern and central regions of the country have also driven migrations to the coastal and Amazon regions. Finally, gold mining has become big business in Madre de Dios with about 15,000-20,000 seasonal miners arriving in Madre de Dios in search of gold from other regions such as Puno and Cusco, in addition to resident miners and Brazilian interests. All these factors have influenced colonization patterns and the subsequent land uses in Madre de Dios.

1) Colonization Objectives

The official objectives of colonizing the Peruvian Amazon are similar to those expressed by other countries in the neotropics. The government of Peru has sought to settle the border areas of the country as a matter of national security to ensure that sovereign territory is safeguarded from foreign invasions. Also, the Peruvian Amazon forests constitute nearly 62% of the country's land area and there exists great pressure to exploit these areas' timber, mineral, agricultural, and energy potentials. Nevertheless, the majority of the large colonization efforts have failed miserably at very significant economic and environmental costs to the country, as has occurred in other Amazonian countries (Repetto, 1988 and Fearnside 1984).

2) The Causes of Failed Settlement Policies and Development Programs

The factors which have impeded the successful development and appropriate management of Peru's tropical forests are discussed and recent policy changes will be studied to identify the effects that these reforms have on the patterns of land use and the rural economy of Madre de Dios. Particular emphasis will be placed on the economic and political welfare of the small colonists in the region because the important decisions that are made by individual households in Madre de Dios will, to a large extent, dictate the fate of this region's tropical forests.

3) Review of the Economic and Social Crises in Peru

To better understand the economic and social conditions of the agricultural sector of Madre de Dios it is necessary first to review the national crises that have evolved over the last several decades in Peru. The planning and policy decisions that are made at the level of the central government have had very important ramifications for the economies of the more isolated regions of Peru which depend heavily on public investments and incentive programs to the agricultural sector.

For the last several decades, and especially since 1985, Peru's economy and society "have been in total disarray" (Paredes and Sachs, 1991). This crisis has been under way since the late 1960s and the military government of General Juan Velasco. This administration, besides carrying out the very controversial program of Agrarian reform, sought to achieve economic self-sufficiency for the country, especially with regard to imports of food. However, the present financial crisis in Peru and the subsequent social dismantling of many areas of the country due to civil unrest and increased terrorist activities can be traced back to this military government. The "exhaustion of the strategy to substitute domestically produced products for imports" was a starting point for this crisis. "Import-substituting industries fostered under the new regime could not support overall growth in the economy, and new export industries could not emerge under an economic strategy with a strong anti-export bias (Paredes and Sachs, 1991)."

In a very short period, Peru was changed from a net exporter of food to a net importer of food as the more productive areas of the agricultural sector became incapacitated and alienated from the

government through a program of agrarian "reform" which confiscated and redistributed the larger private land holdings to the other more disadvantaged segments of society. Although this program was designed to redistribute income and land, the results were massive capital flight to other sectors of the economy, decreasing production, and increased government involvement and spending in support of an agricultural sector in decline. This legacy of direct government involvement in the import and export industries, and the agricultural sector in particular, has distorted the efficiency of the market in Peru and created serious disincentives for private investments which have continued to the present.

Since the beginning of the APRA administration in 1985 the government's financial policy was oriented toward enhancing its control over financial institutions and credit allocation (World Bank, 1988). In July of 1987, the commercial banks, insurance companies, and finance houses were nationalized in an atmosphere of dangerous political tension. Following a relatively stable period in 1986-1987 in which inflation and interest rates remained rather unchanged, the inflation rate began to increase violently in the wake of unfettered spending by the public sector (heavy financial subsidies and credits channeled by development banks such as the Banco Agrario), an overvalued local currency, and reduced savings by the private sector (see Figure 3).

Also, the government began to print more money in an effort to supply the greater demand for cash due to the continuously increasing absolute prices of most commodities (Relative price distortions, fueled by price controls and targeted subsidies, also complicated

matters). During this period of runaway hyperinflation and increasingly negative real interest rates (1987-1990), real wages were reduced (so spending power decreased substantially), the government was unable to generate revenues from taxes, and informal economic activities grew to encompass nearly 40% of the country's production of goods and services recorded in the national accounts (De Soto, 1986) (see Table 8).

The rapid growth of the informal sector has been in large part due to "the government's growth strategies in the past few decades and the increased intervention and regulation that accompanied them [which] have not incorporated a large part of the population into the modern economic sector" (Paredes and Sachs, 1991). These displaced segments of the population comprise the bulk of the settlers seeking better opportunities in the urban centers and tropical forest regions. The importance of the informal economy is especially relevant in Madre de Dios because the Subregional economy is largely supported by gold mining and extractive activities, which may greatly increase in significance in the wake of the recent crises affecting agriculture and forestry.

B) The Agricultural Sector and the Banco Agrario: Credits and Subsidies

Credits and subsidies have long been available for activities that promote the settlement of isolated areas and the development of rural economies throughout Peru. The disrupting effects of cheap credit on rural agriculture and development has been well documented in the literature. Of course, many businesses and protected sectors of the

economy in urban centers have also been the recipients of favorable economic incentives, but this study will concentrate on those programs which have promoted the rural development and the agricultural sector in particular. Again, it is important to note that these incentive programs have frequently led to destructive and irrational use of forested lands and other natural resources. This phenomenon is widespread throughout the world and is not unique to tropical developing countries.

"Many governments have deliberately adopted policies that accelerate the conversion of forest lands to farming and ranching, through incentives that artificially lower the costs and increase the private profitability of the alternative land uses. These subsidies can become so large that they encourage activities that are intrinsically uneconomic or push alternative land uses beyond the limits of economic rationality. When this happens, inferior and often unsustainable land uses are established, only because of the subsidies." (Repetto, 1988)

In Madre de Dios there are certain important government entities which carry out the central government's mandates pertaining to the distribution of capital and services for the benefit of the rural population. These entities include the Banco Agrario, until recently the principal source of credit and loans to the agricultural sector and the most accessible financial institution in Madre de Dios and other rural regions of Peru. Two other state agencies that have played an important role in the promotion of agricultural activities in many regions are ECASA (The National Rice Marketing Agency) and ENCI (The National Marketing Agency for Basic Foods and Agricultural Inputs).

The Banco Agrario del Peru has one main branch located in Puerto Maldonado and three agencies in Iberia, Mazuco, and Iñapari. The bank's principal function is to distribute credits and low-interest

loans to the agricultural sector of the Subregion and in general assist financially the agricultural (which includes livestock and forest extractive activities) development of these rural areas. The Banco Agrario is a state bank which receives its funding from the Banco Central de Reserva del Peru.

The agricultural sector and the more depressed regions of the country have continued to be supported by very substantial subsidy, credit, and loan programs and benefitted from infrastructural development projects even while the rest of the economy was facing a extremely precarious financial situation. In essence, the government was spending money it did not have on poor investments in agriculture and other favored activities which have had the direct effect of encouraging forest conversion.

The Banco Agrario was mandated until mid-1991 to provide the farmers and cattle ranchers of Madre de Dios and other regions with the financial resources necessary to carry out their high-risk activities at interest rates far below the commercial interest rates (which resulted in negative real interest rates when inflation was accounted for). The discrepancy between the promotional interest rates offered by the Banco Agrario and the commercial interest rates was supposed to be recovered with periodic payments to the Banco Agrario by the Banco Central de Reserva (unpublished documents, Banco Agrario del Peru). The present problems resulted because these payments were never fully covered by the government's treasury and the Banco Agrario began to lose liquidity. This problem culminated in the inability of the Banco Agrario to continue offering low-interest loans and financing subsidies to agriculture during the latter months of

1990. To date, the Banco Agrario estimates that the state owes the bank over \$360,000,000 (Roger Ruiz, pers. comm. and own obs.).

Since March 1991, the Banco Agrario has been operating as a commercial bank and has not been offering the promotional interest rates that helped to artificially support the agricultural sector for many years. To make matters worse, many farmers of Madre de Dios did not receive the third and final loan disbursement from the Banco Agrario in March of 1991 which would have paid for the costs of harvest and marketing of the products. In addition, the bank claimed that no further loans would be offered to settlers that had accumulated debts with the bank. This failure of the Banco Agrario to provide much needed and anticipated financial support was perceived by the farming communities as an affront to the agricultural sector and these farmers condemned the Banco Agrario and the central government in a very visible series of public demonstrations throughout the region during the months of June through August of 1991. These demonstrations included roadblocks and restrictions of river transport which resulted in temporary food shortages in Puerto Maldonado (Sur, July 26 to August 1, 1991). In an effort to appease the farmers and minimize the negative political impact of this agricultural crisis, the local government and the Ministry of Agriculture expressed dismay with the Banco Agrario and the central government and expressed their support of the farmers' grievances.

Today, in Madre de Dios and other regions of Peru the Banco Agrario is operating as any other commercial bank, using commercial interest rates and trying to collect its debts. The official objectives of the Banco Agrario for the period 1990-1995 is:

"...to orient the agricultural credit towards the development of the national agricultural sector, preferentially to foodstuffs of national origin, within a context of integral rural development, which stimulates appropriate land tenure systems which are efficient and commercially competitive, assuring a transformation of the rural productive sector which emphasizes the promotion of small agricultural operations and the small farmers of the rural and native communities." (own translation, Banco Agrario del Peru, 1991)

Also, the Banco Agrario has begun to charge the appropriate taxes on commissions and interest received from the bank. Several policy changes regarding the financing of agriculture are expected for the period 1991-1995 which are outlined by the Banco Agrario:

- There will be a greater participation of the commercial financial institutions in the agricultural sector.
- A program of stabilization of the prices of agricultural goods will be implemented.
- Subsidies for agricultural inputs and state-financed agricultural credits will be removed.
- State credit will be made selective for the more economically depressed regions of the country and there should be greater participation in agricultural investments by the private sector.
- The gradual retirement of the Banco Central de Reserva's support of the activities of the Banco Agrario del Peru.

(own translation, Banco Agrario del Peru, 1991)

The majority of the farmers, ranchers, and loggers who were interviewed during the research phase of this report stated that the financial support of the Banco Agrario had been very important in ensuring the continued economic viability of their various activities. Furthermore, many colonists felt that in the absence of these credits and subsidies, the agricultural sector in Madre de Dios would be doomed to failure. Nevertheless, the frequent mismanagement of the financing received from the Banco Agrario and the fraudulent use of

the bank's loans by some settlers also contributed to the failure of the incentive programs.

The Subregional government has very limited resources to devote to the verification and monitoring of the activities of the settlers scattered throughout the region. In many instances, the Banco Agrario gave money away to just about anyone who asked for it without seeking to determine that individual's ability to pay back the loan or ensure the productivity of the land. For instance, one settler expressed frustration with a neighbor's use of cattle received through the Banco Agrario: "As soon as he [the neighbor] received the cows and bull from the bank, he simply sold them to other colonos for a cheap price. He knew that the bank would never bother to investigate what he had done with those animals that were supposed to be a source of continued income for him. Many people waste the money that the bank is providing and this has caused the present problems [of the bank suspending the credit and subsidy programs]. (pers. obs.)"

The Banco Agrario must reevaluate the future role of its activities as the central government cuts back the expenditures for credit programs to the public and private sectors. The priorities for the development of Madre de Dios must be established within a context of long-term planning and sustainability. These policies must foster an awareness of the environmental concerns of these ecosystems, generate estimates of the human carrying capacities of these forests, and perhaps most importantly, assess the effects of the present economic and political reforms on the many land use decisions made by each and every settler. The lack of financial resources and well-trained technical personnel, the highly dispersed nature of farms and

settlements, the lack of adequate transportation and communication, and the very risky and unpredictable nature of land use activities in these tropical forests have considerably limited the ability of the Banco Agrario (and the Ministry of Agriculture) to keep track of and coordinate the activities of the many small farmers in Madre de Dios. The government's programs to settle and develop the lowland forests of Madre de Dios must incorporate an incentive structure which promotes the conservation and proper management of the forests' resources and simultaneously creates disincentives to the chaotic and inefficient colonization and land uses which presently characterize human exploitation of the forests of Madre de Dios.

C) Public Investment, the Tax Structure, and the Local Budget

Direct government investment into the economy of Madre de Dios is crucial because the region receives a very limited amount of private investment. Generally, the inhabitants of this region seek to invest in other regions of the country because the opportunities are greater and more varied. Also, the isolation of Madre de Dios leads many to consider this region an economic dead-end.

Another factor that has limited private investment in Madre de Dios is the widespread perception that the central and local governments have the responsibility or duty to provide the area with the social services, physical infrastructure, and financial incentives which have always been available. Recent reforms have brought about fundamental changes in the relationship between the central government and the regional governments of Peru, creating a need for new sources of investment and financing to be generated from within each region.

Madre de Dios will experience a difficult period of readjustment as public investment decreases and the private sector is forced to provide a greater proportion of the capital assets required to continue developing the local economy and society.

Another problem that the local government of Madre de Dios has been facing is the failure to collect tax revenue from the inhabitants of this region due to long-time exemptions and the isolated, dispersed, and informal nature of many settlements and land-use activities in the Subregion. The principal source of government revenue in the region, a 3% tax on the sale of gold to the Banco Minero, has not been collected since the suspension of gold purchases.

The present tax structure exempts many businesses and individuals in the tropical forest regions of Peru from paying taxes. This program was designed to create a further incentive to settle and invest in these depressed areas, but the burden of financing colonization schemes, rural infrastructure projects, and public credit programs (aside from the daily administrative costs of the various government entities) has exceeded the government's ability to pay for these services.

For instance, by the month of July 1991, the local subregional government had only received about I/m 957,281 of the annual budget of the I/m 7,900,000 (about 12% of the year's budget, equivalent to approximately US \$1,156,136.5 at I/m .828/US\$) from the Inka regional government in Cusco (Gustavo Vera Morales, pers. comm.). With these very limited financial resources the Subregion could barely pay the wages of the public sector employees which has resulted in strikes and substantial cutbacks of public employees in Madre de Dios. There is

substantial cutbacks of public employees in Madre de Dios. There is no money available to pay for any of the government's programs, projects, or material requirements and the policymaking process has come to a virtual standstill. Needless to say, the lack of adequate funding has been an overriding problem for Madre de Dios which has been exacerbated by the recently adopted process of regionalization and the excessive political conflicts within the policy making process.

D) Rural Land Tenure in Madre de Dios

The predominant type of land tenure in the rural zones of Madre de Dios are agricultural and forestry concessions of government-owned land given by the Ministry of Agriculture to the settlers that inhabit the Subregion. The concessions are another form of incentive to "develop" the tropical forest lowlands that have thus far remained largely unutilized and have greatly facilitated small farmer expansion into forested lands. These concessions and the public ownership of the forests' resources have also disrupted traditional property rights of local authorities and communities, including native Amazonian peoples who inhabit the area. And, "although intended to strengthen control, such actions have more often undermined local rules governing access and use, removed local incentives for conservation, and saddled central governments with far-flung responsibilities beyond their administrative capabilities" (Repetto, 1988).

The characteristics of forest land tenure in Madre de Dios have also worsened the conflict between competing land uses such as selective logging, shifting cultivation, pasture, and non-wood

extractive activities, notably Brazil nut (Bertholetia excelsa) and natural rubber (Hevea brasiliensis) collection.

Apart from being intrinsically difficult to monitor and administer, the present system of property rights also creates a disincentive to appropriately manage the tropical forests because these concessions are of short duration and in many cases encompass excessive areas of land.

Generally, these concessions have a relatively short duration of between 2 and 15 years depending on the financial and political means of the settler who has requested the concession. For instance, the average single family obtains a certificate of possession to exploit the land for a period of two years. This concession is then subject to renewal every two years for as long as the settler (the head of the household) has interest in that particular parcel of land. Since the settler owns the rights to exploit the resources of the land that he/she has obtained from the government without restrictions or future obligations to that land, short-term non-sustainable land uses are favored over sustained management practices that do not degrade the forests.

These smaller concessionaires can generally persuade the government to provide them with a concession of up to 1000 hectares. The vast amount of forest land that is yearly being passed on to settlers with very limited capital and technological assets has led to inefficient and indiscriminate use of these forested lands. And, very few of these small farmers have the ability to exploit these large concessions successfully.

Another factor that leads to indiscriminate exploitation of the forests and "unlawful" transfers of land use rights among private parties is the inability of the government to verify, monitor, and otherwise control the actual use of the land. This situation has been complicated by the highly dispersed nature of the settlements which occupy much of the territory. The settlers of Madre de Dios are fully aware of the government's limitations and many do not hesitate to take advantage of the situation.

The following sections will describe some of the necessary policy improvements which could be implemented in Madre de Dios to achieve more sustained rural development.

VII. Alternative Land Uses, Policy Reforms, and Recommendations

An evaluation of the agricultural economy and present land uses of the lowland tropical forests of the Subregion of Madre de Dios in southeastern Peru reveals some very serious inefficiencies and problems which must be resolved to ensure a more appropriate exploitation of forest resources and achieve a sustainable program of rural economic development. Although these two objectives seem to contradict one another, the future of many tropical forest regions greatly depends on the implementation of management strategies which assure positive economic growth within the ecological limitations of these very valuable and diverse ecosystems. There is an absolutely critical need to merge the scientific, economic, and policy knowledge that have been generated throughout the world to address this most difficult yet important issue of tropical lands' management.

The significance of reforming land use policies for Madre de Dios is of particular urgency because this area represents one of the last great expanses of undisturbed tropical lowland forests of the Upper Amazon basin, the most biologically diverse region of the world.

The recommendations are divided into agricultural, forestry, and economic although many reforms will encompass and require the participation of several sectors and local policy making mechanisms. In particular, this information is intended to provide local development agencies, non-governmental organizations, extension agents, and the government with a common reference of information about possible policy improvements and point out the importance of a well-coordinated planning process between all relevant groups. A

coordinated effort between the various government agencies is crucial because these agencies frequently operate completely independently of one another and this lack of cooperation has itself created many problems.

Also, there are many tropical land management systems that are being attempted throughout the world, but policy-makers in Madre de Dios do not have access to this vital information. The following section should provide some useful guidelines and information about the strategies of forest land uses and rural development models that could potentially improve the chances of properly managing and conserving the lowland tropical forests of Madre de Dios. These measures also take into account the need to better the social and economic welfare of the rural peoples of this Subregion and describe the land use patterns and economic relationships that may result from the adoption of the recommendations.

The recommendations will be specific to the particular economic, political, and environmental characteristics of this particular region. It is vital that management plans for tropical forests be specific to the area that is being addressed because too general an approach may fail to account for very distinct factors such as, for example: local infrastructure, political frameworks, financial resources, cultural biases, or ecological constraints.

A) Land Use Improvements: Agriculture and Forestry

Tropical agriculture is at present an area of intense research because many of the aspirations of developing countries rely on the economic productivity of vast expanses of tropical forests. Also, these relatively scarcely populated and isolated areas are considered one of the solutions to the problems of population and land pressures in other areas of the country. For example, nearly 62% (approximately 79 million hectares) of Peru's territory is covered by tropical forests extending eastward from the eastern slopes of the Andes mountains, yet only 12% of the country's total population lives in these regions.

One very important land use activity that is badly in need of reform is agriculture and cropping systems specifically. The agricultural systems and policies which have been implemented in Madre de Dios have been largely unsuccessful (even if evaluated on their economic merits alone) and have in fact resulted in many financial and environmental losses. The first task, therefore, is to determine the agricultural systems that should be promoted by the central and local governments to retain the productivity of those lands that have already been cleared or otherwise disturbed. A program of economic reform is presently being implemented that has removed some of the perverse incentives to agriculture, but land tenure reform must also be undertaken to complement the new economic policy and encourage appropriate management.

There is an urgent need for soil surveys and other ecological studies which would provide policymakers with the information about

the forest resources which is necessary before undertaking any management strategy for these lowland tropical forests. The absence of such information has seriously hampered the functions of INIAA, INADE, the Ministry of Agriculture, local NGOs, and most importantly the rural settlers of Madre de Dios. For instance, INIAA has a soils' laboratory which cannot be utilized due to the lack of materials and personnel trained in conducting these kinds of studies. The government should, at the very least, immediately provide the agency with the funds required to carry out such studies.

Just as importantly, these agricultural systems must be economically sound and strive to render the land productive for the long-run. The continued waste of financial and human resources that have resulted from past government policies which sought to settle the lowland forests of Madre de Dios could be avoided by gaining a greater understanding of the economic and infrastructural limitations of the Subregion. It is now clear that the present limitations to rural development in Madre de Dios will not allow the large-scale human settlement of the area nor the burgeoning agricultural production that past policymakers had envisioned. However, the quality of life of the rural settlers of Madre de Dios can be improved with the implementation of management techniques that are available today. Likewise, the natural resources and biological diversity of the lowland tropical forests could be more adequately conserved through the adoption of improved agricultural practices.

These improved agricultural systems should not be dependent on a high level of technification and/or agricultural inputs due to the high costs of these production inputs and, likewise, these systems

should recognize the limitations caused by the poor channels of communication and transportation in Madre de Dios.

The implementation of the following agricultural cropping systems should be further investigated and government programs should strive to promote these less capital-intensive and more environmentally benign systems.

1) Multicrops and Intercrops vs. Monocrops:

Monocrops are highly undesirable on the nutrient poor soils of much of the Amazon basin because the repeated removal of the entire plant cover (and thus the nutrient-rich vegetable biomass) impoverishes the soils very quickly and increases the leaching of the remaining nutrients. Moreover, monocropping is particularly susceptible to pests and plagues due to the lowered diversity of vegetation compared to mature forest or even mixed crop or agroforestry systems.

Other problems with monocrops stem from the fact that unpredictable environmental factors such as climate and rainfall regime and economic risks such as distorted local prices and fluctuating demand can endanger the economic profitability of a single crop. Using a multicrop system could also even out the production of commercially valuable products throughout the year and contribute to steadying the generation of income.

Planting monospecific crops such as upland rice or maize generally entails clearing the land of all other vegetation prior to cultivation. The majority of nutrients in a tropical forest system are found in the standing biomass. Although burning the vegetation

debris following clearing does return some small proportion of these nutrients to the topsoil, repeated clearing, burning and harvesting will render the soil practically sterile after several years of such use. Multicropping and intercropping allow for the maintenance of some vegetation cover throughout the entire year and the use of nitrogen- fixing plants or trees (legumes) and green mulch (ex. crop residues, tropical kudzu (Pueraria spp.), etc.) can help attain sustained yield for longer periods than monocrops (See Appendix A).

In a series of experiments testing the ecological feasibility of monocrops on upland Ultisols in Yurimaguas (northern Peru) researchers concluded that monocrops were undesirable because of the increased susceptibility to pathogens: "Continuous monoculture of the same crops...did not produce sustained yields because of pathogen build-ups" (Bandy and Sanchez, 1986 and Nicholaides et al. 1985). Also, "pest outbreaks...are frequently more severe in monocultures than in intercrops...[partly because the lower plant diversity in monocultures] supports a less diverse insect community" (Horwith, 1985). This lowered plant and insect diversity means a reduction of natural enemies to the pests and stands of monospecific annual crops "may be even more susceptible to disruption because they are simple, human-made communities that have not been 'tested' on an evolutionary time scale" (Horwith, 1985). The pests that may attack a monocrop such as the upland rice can also become resistant to pesticides in a relatively short time. In fact, the petrochemicals that are used in increasing amounts in many temperate zones may be quite dangerous to the environment and should not be utilized in tropical forest lands

Multicropping can also alleviate a certain amount of the economic risk of depending on a single crop to generate the income of a farm. Seasonal changes in rainfall may cause periods of relative drought (May to September) which may negatively affect some crops in certain areas of the sub-region, such as the poorly drained upland sites. A greater diversity of crops on a given plot will help guarantee some economic return as certain crops will benefit from the particular climatic conditions during any given agricultural cycle.

Monocropping combined with the predominant system of shifting cultivation in Madre de Dios also forces the rural settlers to continue clearing areas of mature or undisturbed tropical forests. Nevertheless, continuous production from a single agricultural field has some obvious advantages besides a decreased rate of conversion of undisturbed tropical forests.

First, the continued use of short secondary forest or "purma" diminishes the amount of labor that is required to clear a new plot from mature forest. This represents direct savings to the farmer at the onset of every agricultural cycle. (Combined with a reformed system of property rights, the need to clear mature forest would decrease in importance.)

Second, the greater amount of time on a particular field will allow adjacent fields a longer fallow period and the process could thus be practiced on a long-term basis by rotating the fields on 10 to 15 year fallow cycles.

Third, promoting the cultivation of the same fields for a longer succession of years facilitates the monitoring and control of land uses by the relevant government agencies. Greater regulation may also

reduce the incidence of indiscriminate land clearing, resolve conflicts between competing land uses, and create an incentive for settlers to more properly manage that particular plot.

2) Low-input Cropping Systems

Soil scientists from North Carolina State University have designed a low-input cropping system for the acid infertile soils of the Peruvian Amazon regions. The research was conducted at Yurimaguas on soils similar to the Ultisols which dominate the upland sites (high terraces) of Madre de Dios. Although the results are site-specific, some useful information can be generated from this research for other locations. In particular, this system is well-suited to the economic and social characteristics of the Subregion. The lack of infrastructure, mechanization, and technification of the farming sector restricts the utilization of more modern or industrial techniques.

The principal features of the system "are slash-and-burn clearing, rotation of acid-tolerant upland rice and cowpea cultivars, maximum residue return, no tillage, and no lime or fertilizer applications" (Sanchez and Benites, 1987). This system was designed as "a transition technology between shifting and continuous cultivation", "preserves some ecosystem diversity and contributes toward a sustainable level of production and income for farmers in humid tropical regions" (Sanchez and Benites, 1987).

The crops must be acid-tolerant such as the selected cultivars, Africano Desconocido rice and Vita 7 cowpeas, which have been used and tested extensively in the Peruvian Amazon (Sanchez and Benites, 1987).

Also, between cropping cycles, a tropical kudzu (Pueraria phaseoloides) fallow could protect the topsoil and control the spread of weeds.

The results of the low-input cropping system tests were encouraging for a continuous cropping cycle of about 7 crops over 3 years, after which another type of land use system should be employed. "A total of 11.5 tons/ha of rice and 2.3 tons/ha of cowpea grain was produced without any fertilizer or lime additions on this soil (Sanchez and Benites, 1987)." The system also proved to be economically profitable, yielding average net returns of US \$1,144 per hectare per year (a 121% return on the investment).

The low-input cropping system, however, should be viewed with some skepticism because there is little likelihood that the small farmers of Madre de Dios could effectively adopt this system and attain the level of success that was achieved by highly trained agronomists. In addition, the pronounced dry season which occurs in Madre de Dios may prevent the possibility of cultivating annual crops year-round. Nevertheless, efforts to distribute this technology throughout the lowland tropical forest regions of Peru should be promoted.

3) Perennial Crops

The crops which should be emphasized and promoted by the government are those that are best adapted to the particular physical and climatic characteristics of the area, namely the indigenous species of commercial value and perennial crops that will offer sustained yields over a number of years and require minimal amounts of

mechanization or expensive inputs. There is evidence that perennials could prove sustainable and profitable:

"Principle reasons for hopes that perennials will prove sustainable are that (1) the products' value, in contrast to annual crops like rice and maize, justifies the cost of supplying nutrient requirements through fertilizers, rather than relying on the small and quickly exhausted stocks in the soil, (2) plant nutrient losses are minimized, as compared with annual crops, due to better recycling within the agroecosystems, since leaves fall to the ground to contribute to soil fertility in plant root zones, and (3) the soil is protected from direct impact of sun and rain in the case of tree crops such as cacao and rubber." (Fearnside, 1985)

Perennials, however, can also be susceptible to pests and diseases and should not be considered permanent crops. The value of these crops will be best secured if the perennials are planted on relatively small fields with a variety of other crops (see Appendix E).

Perennial crops and multicropping are exciting new developments in tropical agricultural research, but the potential is relatively low for these techniques to increase production or alleviate the economic problems of the agricultural sector of Madre de Dios. The government should therefore not continue promoting extensive agricultural development of this region at present until certain important problems are resolved.

The most significant constraints to the success of any system of extensive commercial agriculture is the lack of all-weather roads and the very limited access to extra-regional markets. Perennial crops could be promoted in Madre de Dios as a method of recovering the productive capabilities of forest lands that have been previously converted to agriculture and pasture use.

Agricultural production should be destined to the local and regional markets only. It is not economically viable today to develop

extensive agricultural systems that require a high level of technification, fertilizers, and mechanization. Finally, the information and extension services that would be required to train local farmers in the application of these techniques are beyond the capacity of the rural development agencies, both public and private, presently working in Madre de Dios.

4) Agroforestry potential in Madre de Dios

Other management alternatives that have received much attention from foresters and agronomists are various agroforestry systems. Again, it is important to note that the systems of agriculture that will result in economic profits and ecosystem conservation of tropical forests must, above all else, preserve soil organic matter and assure the maintenance of the nutrient cycling mechanisms of the entire forest (Jordan, 1985 and Jordan, 1989).

Ideally, the agricultural systems that should replace shifting cultivation need to simulate the natural regeneration of tropical forests by promoting the gradual recovery of the soils' nutrients and the buildup of organic matter in the topsoil. These sustained-yield agroecosystems mimic forest succession with plants useful to humans at every stage of the cycle (Newman, 1991). These system could utilize a wide variety of plants and trees at every stage, but species must be selected which best satisfy local demand, ecological conditions (such as acid-tolerance), and other site-specific factors (see Appendix F).

5) Tree Plantations

Tree plantations using indigenous and acid-tolerant tree species should be actively promoted as a means of removing the pressures on the mature forests from wood extraction activities. As we have seen, selective logging is presently not economically viable or environmentally sound. The loggers of the Subregion would accept the idea of growing plantations of the more commercially valuable tree species if the land tenure system were reformed to include legal titles of the land holdings. Without secure rights to the land the small settlers (and larger logging operations will not accept any program which yields benefits in the distant future).

Research must be promoted to establish tree plantations on the marginal lands which have been sufficiently degraded to have little value as wildlife habitat. Also, these marginal or secondary forest lands must be protected from the ravages of erosion. The permanent cover offered by tree plantations would be a more appropriate use of these lands than the continuous agriculture and pasture (and subsequent abandonment) to which the forests are now being subjected.

Much research is being carried out to investigate the tree species which are most well-adapted to a plantation system. The most important considerations when selecting tree species are disease and acid-tolerance. Some of the more commercially valuable tree species which occur naturally in Madre de Dios should be further studied for plantations and a greater range of species should be marketed (see Appendices E and F).

VIII. Policy Recommendations:

A) Agriculture and Forestry Improvements

1) Monocrops should not be promoted in Madre de Dios. Certain annual crops which have been actively promoted by public investment and extension programs such as rice and maize have been shown to be both environmentally and economically undesirable. Instead, improved systems of multicrops and intercrops should be further investigated by INIAA and INADE. The public funds which are saved from the suspension of irrational support programs such as ECASA (the Rice Marketing Board) and ENCI (the National Marketing Agency for Basic Foods and Agricultural Inputs) could be redirected to the distribution of information, the improvement and strengthening of extension services (both public and private), and the promotion of scientific research of the forest and soil resources.

2) The ecology of the forests of Madre de Dios should be studied to facilitate the development of environmentally sound management policies. In particular, a comprehensive soil survey and forest inventory should be completed by the relevant national and international organizations. These tasks could be carried out in cooperative agreements between the local government and local and international NGOs. The involvement of international development and environmental NGOs should be encouraged as possible sources of funding, new ideas, and technical expertise. These important elements

of the decision-making process are absent in Madre de Dios. This situation has severely hampered rural development programs.

3) Rural settlers should be encouraged to increase the intensive use and productivity of the marginal or "purma" lands. Also, the areas of greater soil fertility which could be targeted as sites of continuous cultivation should be identified. The system of low-input cropping developed by researchers at Yurimaguas should be promoted on the more fertile alluvial sites. The upland terraced sites are drought prone throughout certain months of the year and annual crops should be discouraged on those sites, which comprise a greater proportion of the total area of lowland tropical forests.

4) Plantation forestry should be investigated for development on the secondary forest lands and on abandoned pasture and agricultural areas. The increasing scarcity of commercially valuable species in the readily accessible areas and increasing transport costs have reduced the production volumes and the economic profitability of selective logging. Plantations have the potential of removing some of the pressures to clear mature forests and could result in greater production of the few tree species which are currently marketable. These plantations should be restricted to the utilization of indigenous tree species which have been proven successful in research programs throughout the neotropics.

Efforts to increase the market value of a wider range of tropical tree species must also be undertaken, although local loggers and

forestry organizations have a very limited ability to influence the national or international market for tropical hardwoods.

5) Certain areas should be designated extractive reserves for the long-term harvest on secondary forest products or non-timber products which have recognized commercial value and existing markets. The first step is to identify the zones of greatest density of these tree and plant species. Second, INADE, the Ministry of Agriculture, and the relevant NGOs should facilitate the formation of cooperatives of extractors such as those that already exist in Planchon and Lago Valencia. By setting up cooperatives, the local extractors could pool their limited resources and more effectively lobby the government for support of these "informal" activities.

The two most important products, rubber (Hevea brasiliensis) and Brazil nuts (Bertholetia excelsa), could benefit from enrichment plantings in natural forest. Growing these species in plantations has proven to be very problematic. The level of quality of the products grown in plantations is suspect and the productivity of the trees in an intensively managed system is lower than that of natural individuals. This is especially true of Brazil nut.

Finally, there must be a concerted effort to promote the development of agroindustrial projects which could add value to the products which are extracted from the forests and retain a greater proportion of the revenue generated locally. At present, most of the income from extractive activities are being captured by middlemen and urban exporters detached from the Subregional rural economy. Some international NGOs have already indicated interest in financing these

types of ventures and the local government should encourage and participate in these efforts. (See Appendix E)

B) Political and Economic Reforms

1) The perverse economic incentives which have been created by the government to promote colonization and agricultural production in the lowland forested regions of Madre de Dios must be removed. Most importantly, the low-interest loans and "zero" credit programs of the Banco Agrario which have recently been suspended due to financial difficulties and the newly adopted economic reforms of the Fujimori government must not be started anew.

Rural development must be guided by projects which are economically feasible, ecologically sound, and which do not burden the government with unnecessary public expenditures. Excessive government interventions have been partly responsible for the social and economic crises which have developed over the past several decades. Besides, these investments into the agricultural sector of Madre de Dios have not resulted in any increase in the standard of living of the rural settlers and has led to indiscriminate use of the forests' resources.

The government should concentrate its efforts towards allowing the use of an appropriate discount rate (determined by the real interest rates used by local financial institutions), stabilizing local price distortions, and discouraging public and private investment in uneconomical and destructive land use activities.

2) The land tenure system of concessions presently employed by the Ministry of Agriculture needs to be replaced with the assignment of legal land titles to the settlers who are presently occupying forest lands in the Subregion. These land titles would create an incentive

for privately motivated management of the forests which could help reverse some of the wasteful and indiscriminate uses of currently government-owned land.

The concession system could be reformed in two important ways as an alternative to land titling. First, the duration of the concession should be increased to a much longer period. Foresters have advised that a minimum of 70 years would ensure that a settler or other logging interest would be guaranteed the property rights to that plot for at least 2 timber harvesting rotations. This extended concession would encourage proper management and reforestation through the replanting of valuable species.

Farmers should be given concessions lasting at least 50 years to encourage soil conservation practices and the adoption of continuous cultivation systems. This system would also discourage shifting cultivation if the settlers were given access to less forest land. A program of long-term concessions should also assign smaller areas to individual settlers in order to promote a more sustained exploitation of the entire concession over time.

Again, either form of land tenure system should target the areas that have been previously exploited and mature forests should be safeguarded against further uses until the most appropriate uses have been identified. Likewise, the Ministry of Agriculture should not assign mature forest lands to settlers who have been in the Subregion for a number of years. The practice of assigning new concessions to all applicants has encouraged the clearing of mature forest and the abandonment of agricultural and pasture lands.

3) All government-sponsored colonization projects in Madre de Dios should be suspended. These programs have failed due to the lack of clear development objectives by the central government, a mistaken assessment of the agricultural potential of this Subregion, bureaucratic sub-optimization, poor infrastructural development, and widely dispersed settlement by the settlers colonizing this region.

In addition, the projects have not succeeded in increasing the standard of living of the rural inhabitants and, until adequate all-weather roads are built, no further rural development will occur.

The government should concentrate the many human settlements of Madre de Dios into fewer, more efficient and manageable communities. "Dispersed settlements make it difficult to carry out projects to improve the quality of life of the population, such as health, education and technical assistance (Gazzo, 1982)." In some cases, as few as three or four families will be considered a community and demand the social services and physical infrastructure for which the government is responsible. Clearly, this situation has led to very inefficient use of public funds and personnel. A reformed property rights system would contribute substantially to expedite the coordination of locating settlers into the optimal areas for human occupation and restrict unlawful colonization of mature tropical forests.

4) The local government bureaucracy should be given greater decision-making powers. Elected officials should refrain from trying to set land use policy and allow the long-term public officials to manage the resources with which they are more familiar.

The process of regionalization has also complicated the policy process by making Madre de Dios subservient to both Lima and Cusco, the seat of the Regional Inka government. The physical, social, and economic characteristics of the Subregion are very different from those of the highlands or coastal regions and the local experts should be the primary arbiters of rural development and forest land management.

5) The laws and decrees which prevent cultivation and forestry activities on steep lands with slopes in excess of 20 degrees and on the margins of rivers and lakes must be enforced. Also, compliance with these laws by the public and private sectors must be ensured.

With the appropriate land tenure reforms which have been outlined, the relevant agencies will have an easier task of determining and verifying the land use practices of the rural settlers. A comprehensive survey of the rural inhabitants of Madre de Dios every 5 years should be sufficient to monitor settlement and verify the uses to which the forested lands are being subjected. This more efficient system of land use assessment would benefit the Ministry of Agriculture significantly.

The surveying should be modeled after the work carried out by Centro Eori and The Ministry of Agriculture for the areas surrounding the Tambopata-Candamo Reserved Zone.

6) The system of national parks and reserved zones should be expanded and the institutions which are responsible for these areas should be strengthened. Manu National Park and the Tambopata-Candamo Reserved

Zone are particularly important large conservation units which require adequate funding and management.

The work which is being conducted by the various local and international environmental and scientific NGOs should be coordinated with the efforts of the relevant local government entities such as the Ministry of Agriculture, INADE, the forestry police, and the Subregional government.

Official recognition and acceptance of the NGOs which are currently working in the area is vital. These organizations can become valuable contributors to the decision making process regarding the management of the lowland tropical forests of the Subregion. NGOs have been the unfair targets of recent criticisms and ludicrous accusations of corruption and fraudulent use of funds. The government must recognize the important assets which these organizations could provide such as funding and technical expertise, two of the most important limitations of the local government in the Subregion.

7) Ecotourism should be strongly promoted throughout the Subregion. This is a very important and promising alternative land use which could become an important source of foreign exchange and ecosystem conservation.

At present, tourism businesses are very limited in scale and the local populace views these operations with a certain amount of skepticism because the profits are not remaining within Madre de Dios. Thus, locally owned tourism ventures, such as the small lodge at Lago Sandoval, should be encouraged and supported by local authorities.

The financial requirements to develop successful ecotourism ventures are few. The physical infrastructure should be constructed from traditional materials and the labor required can be satisfied with relatively few people. Moreover, rural communities should be encouraged to develop this industry to provide local settlers and native peoples with another source of funds.

Apart from the obvious environmental benefits of ecotourism, this activity could further diversify the economic portfolio of rural communities. This industry has been growing rapidly and the Subregion could benefit greatly from its reputation as the biological capital of the world.

VIII. Appendices

Appendix A

Map of Madre de Dios

ÁREAS Y POBLACION

AREA: DEPARTAMENTO MADRE DE DIOS
 Población: 100.000
 Superficie: 10.000 km²
 Densidad: 10 hab/km²

COORDENADAS GEOGRAFICAS

Latitud: 12° 30' S
 Longitud: 74° 30' W

Altitud: 1.000 m

Superficie: 10.000 km²

Población: 100.000

Densidad: 10 hab/km²

Superficie: 10.000 km²

Población: 100.000

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Superficie: 10.000 km²

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Población: 100.000

Densidad: 10 hab/km²

Superficie: 10.000 km²

UBICACION



LORETO

BRASIL

CUSCO

BOLIVIA

TAMBOPATA

CUSCO

PUNO



DEPARTAMENTO DE MADRE DE DIOS

ALCAIDE: PEDRO PABLO
 COMISARIO: JOSE EL
 GOBIERNO REGIONAL NACIONAL

PROVINCIA	CANTON	POBLACION
ALTA	ALTA	100.000
BAJA	BAJA	100.000
...



Appendix B

Soils of the lowland tropical forests of Madre de Dios:

Among the most significant factors inhibiting the sustained development of the forest lands of Madre de Dios are the region's soil resources. An appropriate management strategy for the soils of this region is an important component of an overall policy of rural development and ecosystem conservation.

The first step in designing a management plan for the soils of Madre de Dios is to conduct a comprehensive soil survey of the region. To date, an accurate soil map and analyses that could be used by land use decision makers and local development entities does not exist for Madre de Dios. The tasks of government agencies such as the Ministry of Agriculture and INIAA are made significantly more difficult in the absence of adequate soils data. These entities must make important decisions regarding the exploitation and development of agricultural and forestry activities, but these decisions are being made in a virtual vacuum of scientific data regarding one of the forests' principal components. It is widely known that the dominant soils of the neotropical rain forests often have chemical and physical constraints that must be understood and resolved before sustained land uses can be developed.

There are very scarce data available on the physical and chemical properties of the soils of the lowland tropical forests of Madre de Dios and other regions of the southern portions of the Peruvian Amazon. In fact, the only study of the natural resources of Madre de

Dios is a document prepared by the ONERN (Oficina Nacional de Evaluación de Recursos Naturales) in 1972. The first administration of President Fernando Belaunde was undertaking a campaign of colonizing the tropical forest areas of the country and sought to compile data regarding the potentials to exploit and develop these areas. This document is still widely used since it is the only source of information about the region's soils, forests, climate, geology, etc. Nevertheless, the fantastic extrapolations and lack of useful ecological and biological information makes this study wholly inadequate as a tool of natural resource policymaking. Also, partly due to the lack of scientifically sound and detailed information about the forests' resources, many decisions pertaining to the uses of these lands do not incorporate the ecological and biological characteristics that must be included in any attempt to develop a sustainable management strategy for the forests of Madre de Dios.

Based on the results of some soil studies completed at several sites in Peru's similar northern tropical forests and a set of results from the INIAA research station at San Bernardo (located 28 km from Puerto Maldonado along the region's main transportation route), some useful recommendations can be derived about the appropriate management strategies for the soils of Madre de Dios.

The most common soils in the Amazon basin are the relatively acid and infertile Oxisols and Ultisols which constitute about 70% of the total area of the basin (Richter and Babbar, 1991). Alfisols, a more nutrient rich alluvial soils are also relatively abundant.

The Oxisols are very highly weathered soils with ochric or umbric epipedons and a characteristic oxic horizon (a mineral horizon at

least 30 cm thick composed of 1:1 lattice clays and highly insoluble minerals such as quartz sand, hydrated oxides of iron and aluminum, low cation exchange capacity, and small amounts of exchangeable bases) (Brady, 1990). These soils represent the familiar red clay soils which cover about 39% of the Brazilian Amazon (Richter and Babbar, 1991). The common myth that the soils of the neotropical rain forests would turn to brick (laterite) and be completely unmanageable following clearing of the forest cover originated with certain Oxisols in mind. "It has been shown that clearing alone will not cause laterization. Breaking of the [clay soil] aggregates by compaction and several cycles of wetting and drying also are necessary (Jordan, 1985)." This irreversible conversion of the soil surface and subsequent forest succession could occur, for instance, through the continuous use of heavy machinery, burning, use of herbicides and removal of plant cover (Uhl et al., 1988).

Oxisols, however, are not very abundant in the Peruvian Amazon (because the soil parent materials in these Upper Amazon regions are geologically too "young") and thus are not of great significance to Madre de Dios. For the purposes of this study, the lands and soils along the two principal roads and other gently sloping upland sites in Madre de Dios are of greatest importance since most of the settler's activities are concentrated in these areas. Thus, the second most common soil order in the Amazon basin, the Ultisols, are carefully evaluated because these types of soils are the dominant soils at the upland sites in Madre de Dios and are present in several different regions of the upper Amazon forests of Peru and this information is

of vital importance to the proper management of the forests of Madre de Dios.

Ultisols are soils with an argillic (clay) horizon and a low-base status. They are highly weathered (though not as much as Oxisols) and are relatively acidic. The subsurface horizons are commonly red, yellow, or gray in color, evidence of accumulation of oxides of iron (Brady, 1990). Often, the major constraints of Ultisols are chemical in nature. The nutrient deficiency and resulting infertility of both the Oxisols and Ultisols can be partly explained by the origins of these soils.

The origin of the soils of the upper Amazon basin

There are three major geological regions in the Amazon basin. The Pre-Cambrian Shield is comprised of the Guiana Shield in the north and the Brazilian Shield in the south. The Central Amazon Basin, a depression formed in the Paleozoic, is also contained on the west by the Andean mountain range, a relatively recent geologic formation. The Andes were formed by the "subduction of the Pacific oceanic [tectonic] plate under the South American plate" which began early in the Mesozoic Era (Newman, 1985). The Andean mountains dammed the western drainage of the Amazon basin and formed an intercontinental lake which discharged to the Atlantic Ocean. This intercontinental lake was over time filled by sediments deposited from the Andes and a "flat-terrace like, dissected plateau of fluvial and lacustrine sedimentary materials" resulted in what is sometimes called the Amazon Planalto (Newman, 1985 and Jordan, 1985).

The Planalto is a gently sloping plain dissected by meandering rivers which consists of a surface layer of kaolinitic clay 10 to 20 meters in thickness. "Kaolinite is one of the most highly weathered materials and consequently lacks the nutrients necessary for plant growth" which has been a major constraint to agriculture and pasture in many tropical forests of Latin America (Jordan, 1985). Leaching and erosion through time has further reduced the fertility of these soils. Yellowish kaolinitic clay terraces comprise the bulk of the land base in the lowland tropical forest regions of Madre de Dios and are the areas of most intense human exploitation. "Ultisols derived from sedimentary parent material are the dominant soils in the area" (Newman, 1985).

The soils of the upland sites in the vicinity of Puerto Maldonado have textures from loamy fine sand to clay. These upland soils have been classified as "Typic Paleustults, in clayey, fine-loamy, and coarse-loamy families" (Newman, 1985). The soils of the nearly level upland sites removed from the rivers and streams are relatively poorly drained and the area has an ustic moisture regime (these soils are dry for just over 90 days, but less than 180 days during the dry season months of May/June through September). These Typic Paleustult Ultisols "are acid and highly weathered with low base status and low cation exchange capacities" (Newman, 1985). In addition, they are phosphorus deficient and aluminum toxic.

Management strategies and other soils of the Peruvian Amazon:

The Ultisols of the upland sites of Madre de Dios must be properly managed to ensure the sustained agricultural and forestry development

of this region of southeastern Peru and to mitigate the need to continue clearing mature tropical forest areas. According to Sanchez, (1990):

Land use management strategies are urgently needed that improve the economic status of subsistence farmers, maintain agricultural productivity on deforested lands and recuperate productivity of degraded lands. Such options will provide sustainable development of the Amazon and other humid tropical regions in a way that satisfies human needs and preserves the ecosystem. These options must be compatible with the various socioeconomic needs in the region so that they are readily and widely adopted. (Sanchez et al., 1990)

Regretfully, the soils of Madre de Dios have not been studied to determine the optimal management and land use potentials of these tropical lands. Until such studies are completed, the scientific data and agricultural research that has been carried out in similar sites of Peru's Amazon must be utilized to appraise the possibilities of sustained management of the soils of Madre de Dios.

The most comprehensive research of the development potentials of the Peruvian Amazon has been carried out in Yurimaguas by North Carolina State University's Tropical Soils Research Program and Peru's INIPA (now INIAA). Some very promising results obtained in Yurimaguas have led scientists to agree that Ultisols respond well to proper management and can thus contribute to agricultural development of regions in which these soils are predominant.

These researchers have concentrated on various management strategies for achieving a sustained use of Ultisols. These various strategies include: complete treatment of the soils with chemical fertilization, liming, and intense management practices, low-input systems for annual crops on level soils, low-input legume-grass

pasture on sloping soils, agroforestry on sloping soils, and paddy rice on alluvial soils.

Although the most promising results were obtained with the generous use of chemical fertilizers and intense management practices, these systems do not conform to the socioeconomic characteristics of the agricultural sector in Madre de Dios. The continuous use of fertilizers, lime, and mechanized and/or advanced agronomic practices could not be economically viable presently in Madre de Dios due insufficient demand and low prices for agricultural products, limited markets, inadequate infrastructure, lack of credit and low-interest loans, and poor roads.

The agricultural systems that warrant the most attention for application in the lowland forests of Madre de Dios are the low-input systems for annual crops on level soils. The investigators at Yurimaguas have developed these agricultural systems with certain farmers in the tropical forests of Peru. "This option is targeted for farmers on acid, infertile soils in rural areas with limited capital and marketing infrastructure" (Sanchez, 1990). The Subregion would benefit greatly from investigating the applicability of these low-input cropping systems for agriculture at the relatively level upland sites of the Subregion (see Table 9).

Appendix C

The Farming Cycle: Upland rice

The agricultural cycle for rice in Madre de Dios follows a well-established schedule of activities from the months of October through April/May. This growing season has been set to coincide with the seasonal rains. The plots that will be cultivated are prepared in advance during the dry season which extends roughly the months of the temperate summer, May through September. Due to the increased temperatures and lack of rainfall in most of the Peruvian amazon throughout the dry season, many locals refer to these months as the "verano" or summer. This apparent misnomer is easily understood if one contrasts the two marked seasons.

In addition to the changes in average daily temperatures and rainfall, cold fronts can sweep through Madre de Dios during the dry season causing the temperature to drop to 50 F. These factors all contribute to the choices made by farmers regarding the optimal growth period for important regional crops such as rice and corn. (See Table 10)

1) Preparation of the plots to be cultivated:

The initial step in preparing a plot of land for cultivation generally involves a process of removing the trees and other vegetation from a previously uncultivated area. This process has given shifting cultivation its other well-known name, slash-and-burn agriculture. During the months of June and July (sometimes beginning as early as May) the regions farmers are busy clearing the new plots, removing the few valuable trees that may be located therein, and then

allowing the debris to dry prior to burning in the months of August and September. The drying period is important to ensure a more thorough burn which removes a significant amount of above ground biomass which is important in determining the total area that will be efficiently cultivated. Most farmers in a tropical rain forest setting will opt to cultivate a newly cleared patch of forest rather than an area which has been recently farmed due to the loss of nutrients which occurs very rapidly following an agricultural or pastoral cycle (see Appendix C). However, some areas that have been allowed to remain fallow for several seasons will be replanted to avoid the labor intensive process of clearing mature forests. Following the preparation of the new plots the field is ready for planting.

2) Planting the crops:

Rice seeds are obtained from the farmer's own supplies and from INIAA, which provides improved varieties of seed which have been produced at the two research stations operated by the agency in the area. A one hectare plot will generally require approximately 12 kg of seed which are planted by hand. This activity will take 10 to 13 person-days to complete and may be repeated once with a reduced amount of seed if the farmer deems it necessary.

3) Removal of weeds:

Agriculture in the Peruvian Amazon, as in other tropical forests, is particularly affected by the invasion of weeds throughout the entire process of cultivation. The rapid regeneration of vegetation

is a very significant hindrance to farmers and cattle ranchers in Madre de Dios. The almost constant struggle against the invasion of weeds has been cited as one of the principle obstacles to the development of sustainable agricultural practices in the tropics (Sanchez and Benites, 1987 and Horwith, 1985).

The most widely used herbicide in Peru's tropical forest regions is Hedonal which, although generally available, is used only on occasion due to the elevated price of the product at remote locations. Thus, hand-weeding continues to be the most widely used method in Peru and other underdeveloped countries today (Regnier and Janke, 1990). A one-liter container of Hedonal was selling for an average price of I/m 5.00 in Puerto Maldonado in March 1991 (about \$4.00 at an exchange rate of I/m .800/US \$). The weeds can also be removed by hand by contracted day-laborers or family labor. The weeding is performed at the time of planting to reduce the competition between the weeds and the crops for nutrients and sunlight (CIPA, 1988)

4) Pest control:

Following the initial months of growth, when the upland rice has begun to mature, it is necessary to take preventative action against the various pests that could damage or consume the crop. The birds that flock to the region's farms during the months of December through January are frightened through the use of scare-crows and strings of empty cans that make noise when blown by the wind. Even so, a significant proportion of a farm's agricultural output could be lost to pests.

The situation is even more serious for the pastures grown by the cattle ranchers. These pastures are frequently attacked by plagues of salivazo and cases of entire pasture fields being lost to these pests have been known to occur (Pedro U. Sanchez, pers. comm.). INIAA has been experimenting with new pasture varieties that may withstand the region's particular pests (ex. *Brachiaria* spp.). In addition, the efforts of the Centro Interamericano de Agricultura Tropical (CIAT) continue to produce valuable information on pest-control technologies and resistant crop varieties which need to be widely disseminated throughout the neotropics. The extension work necessary to educate farmers in tropical forest areas about the unique characteristics of agriculture on these lands is a vital component of any rational development strategy for these rural communities and must be actively promoted.

5) Harvest:

Five months after planting the seeds, the rice begins to mature and is then ready to be harvested. The harvest must be carried out in a relatively short time once the rice has matured. The laborers are paid on a daily basis according to the amount harvested (in kg), which includes the stalks. As indicated by several official sources as well as by the farmers of the region, one hectare will generally yield about 1,500 kg of rice on a new plot. If a plot has been previously cultivated the yield will be decreased (The most common figures are 1000 kg for a two year old plot and about 500-700 kg for a three year old plot. Only very rarely is the same plot cultivated for more than three consecutive years due to the lowered yields).

6) Threshing and Fanning (or winnowing):

Once dry, the rice is separated from the stalks by shaking and beating the stalks to force the rice grains to fall off. The rice grains are then fanned by allowing the breeze to remove the excess vegetation and other debris from the rice that will be packaged for the market.

The final steps in the production cycle of the rice is to package the crop and transport the sacks to Puerto Maldonado. However, this stage has become very problematic for the farmers of Madre de Dios due largely to the increasing costs of transport, the depressed prices of agricultural goods at the local markets, and the failure of ECASA.

Appendix D

Estimates of Forest Conversion

It is estimated that approximately 95% of the tropical forests in Madre de Dios are still devoid of human exploitation (John Terborgh pers. comm., own estimates, and Dourojeanni, 1990). On a national level, Peru has been experiencing an annual deforestation rate of about 0.4% and the total deforested area may approach 7,499,000 ha (an area about 90% the size of Madre de Dios!) (Dourojeanni, 1990). In 1979, about 254,000 ha of Peru's forests were converted annually to other uses and this area is expected to rise to about 340,000 ha by the year 2000 (Dourojeanni, 1990)). Although accurate data on the actual extent of deforested and degraded lands in the Subregion (and other regions of the country) are not available, some useful estimates and trends can be derived from available information.

There are about 657 km of roads in Madre de Dios which meet minimum quality requirements for some part of the year (Subregion Madre de Dios, 1991). Assuming that most of the lands within a distance of 5 km from these roads have been impacted by human land use activities, a maximum area of 65,700 km² or 657,000 ha can be considered exploited (Carlos Sanchez and Frank Cruz Sisniegas, pers. comms. and own estimates).

In addition, land uses have also affected the forests along the principal rivers of the region. However, human incursion into the forests from the rivers has been minimal, especially at greater distances from the principal population centers. The total area of land along the navigable rivers which has been in some way altered by

human activities probably does not exceed 20,000 to 30,000 ha (own estimate). The sum of the two areas (along the roads and navigable rivers) results in a maximum estimated area of human exploitation of close to 700,000 ha. This number is most likely an overestimate of the actual extent of forest conversion because many of these lands are in a state of advanced regeneration, but this estimate gives some indication of the intensity of human exploitation of the Subregion.

Appendix E

List of Tree Species with Commercial Potential

<u>Common name(s)</u>	<u>Scientific name</u>	<u>Family</u>
* Aceituna (tahuari)	<i>Vitex pseudolea</i>	Verbenaceae
* Achiua	<i>Cybistax</i> spp.	Bignoniaceae
Achiote (achotillo)	<i>Bixa orrelleana</i>	Bixaceae
Aguaaje	<i>Mauritia flexuosa</i>	Palmae
Ajos quiro	<i>Gallesia integrifolia</i>	Phytolaccaceae
* Alcanfor moena	<i>Ocotea costulata</i>	Lauraceae
* Almendra(o)	<i>Caryocar glabrum</i>	Caryocaraceae
* Almendrillo	<i>Cordia nodosa</i>	Boraginaceae
Amasisa	<i>Erythrina glaucea</i>	Leguminosae
Anona (anonilla)	<i>Annona squamosa</i>	Annonaceae
* Apacharama	<i>Licania brittietiana</i>	Chrysobalanaceae
Atadijo	<i>Trema micracantha</i>	Ulmaceae
* Azucar huayo	<i>Hymenaea oblongifolia</i>	Leguminosae
	<i>H. courbaril</i>	
Azufrillo		
* Balata	<i>Manilkara surinamensis</i>	Sapotaceae
Bellaco caspi	<i>Pachyra acuatica</i>	Bombacaceae
Cacahuillo	<i>Theobroma</i> spp.	Sterculiaceae
Caimito	<i>Pouteria caimito</i>	Sapotaceae
* Canelón	<i>Ocotea</i> spp.	Lauraceae
Canilla de vieja	<i>Rinorea</i> spp.	Violaceae
* Caoba	<i>Swietenia macrophylla</i>	Meliaceae
* Capirona	<i>Calycophyllum spruceanum</i>	Meliaceae
Cara huasca	<i>Guatteria hyposericea</i>	Annonaceae
Cashilla		
Castana	<i>Bertholetia excelsa</i>	Lethycidaceae
* Catahua	<i>Hura crepitans</i>	Euphorbiaceae
Caucho	<i>Castilla ulei</i>	Moraceae
* Cedrillo	<i>Cedrela</i> spp.	Meliaceae
* Cedro	<i>Cedrela odorata</i>	Meliaceae
* Cetico	<i>Cecropia fisifolia</i>	Moraceae
	<i>C. membranacea</i>	
Chonta	<i>Bactris</i> spp.	Palmae
* Coloradillo	<i>Eschweilera</i> spp.	Lecythidaceae
* Copaiba	<i>Copaifera reticulata</i>	Leguminosae
* Copal caspi	<i>Tetragastris altissima</i>	Burseraceae
Coquino		
Costilla de venado		
Coto de papaya		
* Cumaceba	<i>Platymiscium ulei</i>	Leguminasae
* Cumala	<i>Iryanthera dialyanthera</i>	Myristicaceae
	<i>virola</i> spp., <i>Otoba</i>	
* Charichuela	<i>Rheedia acuminata</i>	Guttiferae
* Charapa huasca	<i>Pterocarpus amazonum</i>	Leguminosae
Chimucua	<i>Pseudolmedia laevigata</i>	Moraceae
* Chatanquira	<i>Diploctropis (purpurea?)</i>	Leguminosae
Chocolatillo		

List of Tree Species with Commercial Potential continued:

Chuchuhuasi	Heisteria pallida	Olacaceae
* Espintana	Oxandra xylopiodes	Annonaceae
* Estoraque	Myroxylon balsamum	Leguminosae
Fariña seca	Ampelocera spp.	Ulmaceae
Goma	Parkia spp.	Leguminosae
* Gutapercha (Caucho-Mashán)	Sapium marmieri	Euphorbiaceae
* Huacamayo caspi	Sickingia spp.	Rubiaceae
Huacapu	Minquartia punctata	
	M. guianensis	Olacaceae
Huangana casha	Sloanea spp.	Elaeocarpaceae
* Hayabilla	Eugenia spp. (Asian)	Myrtaceae
* Huarmi caspi	Cordia cicuticosa	Boraginaceae
* Huayruro	Ormosia amazonica	Leguminosae
Huayo blanco		
* Huimba(ceiba, lupuna)	Ceiba pentandra	Bombacaceae
* Huito	Genipa americana	Rubiaceae
Ishiquillo		
Isigo		
Itahuba	Mezilaurus itauba	Lauraceae
* Lagarto caspi	Calophyllum brasiliense	Lauraceae
* Leche Leche	Brosimum spp.	Moraceae
* Limoncillo	Zanthoxylum spp.	Rubiaceae
Loro micuna	Ferdinandusa chlorantha	Rutaceae
Lucuma	Lucuma spp.	Sapotaceae
Lupuna (lupunilla)	Chorisia insignis	Bombacaceae
Mejarandu		
* Melacón (ishpingo)	Jacaranda Copaia	Bignoniaceae
* Manchinga	Brosimum alicastrum	Moraceae
Maracuya	Passiflora edulis	Pasifloraceae
* Marañon	Anacardium occidentale	Anacardiaceae
Marazundillo		
Marfil	Phytelephas spp.	Palmaceae
* Mashonaste	Clarisia racemosa	Moraceae
Mata Palo		
Mentol		
* Misa	Escheweilera	Lecythidaceae
Mishu chaque	Perebea spp.	Moraceae
* Moenas	Aniba spp., nectandra grandis	Lauraceae
	Erythroxylum momacoa	Erythroxylaceae
* Motelo caspi	Murraya paniculata	Rutaceae
Naranjillo	Ficus insipida	Moraceae
Oje	Phaedranassa megistropylla	Amarilidaceae
Oreja de burro		
Oreja de mono		
Palmito	Iriarteia spp.	Palmae
Palo de agua	Allophylus	Sapindaceae
Palo Ají	Casearia macrophylla	Flacourtiaceae
Palo Amarillo	Bocconia pearcei	Papaveraceae
Palo Ana	Apuleia molaris	Leguminosae
* Palo Azufre	Symphonia globulifera	Guttiferae

List of Tree Species with Commercial Potential continued:

* Palo Santo	<i>Triplaris americana</i>	Leguminosae
Palo Soga		
Palta (aguacate)	<i>Persea americana</i>	
Pama	<i>Pseuldomeia</i>	Moraceae
Papaya	<i>Carica papaya</i>	
Pashaco (blanco, colorado)	<i>Schizolobium amazonicum</i>	Leguminosae
* Paujil ruro	<i>Guarea multiflora</i>	Meliaceae
* Peine de mono	<i>Apeiba membranacea</i>	Tiliaceae
Pino (?)	<i>Alseis peruviana</i> (sp)	Rubiaceae
* Puma quiro	<i>Aspidosperma macrocarpon</i>	Apocynaceae
* Quillo bordon	<i>Aspidosperma vargassii</i>	Apocynaceae
* Quina quina (quinina)	<i>Pouteria torta</i>	Sapotaceae
* Quinilla colorada	<i>Manilkara surimanensis</i>	Sapotaceae
Quinilla blanca	<i>Pouteria ulei</i>	Sapotaceae
* Remo caspi	<i>Aspidosperma macrophylla</i>	Apocynaceae
Renaco	<i>Ficus trigona</i>	Moraceae
* Requia	<i>Guarea guidonia</i>	Meliaceae
Retama	<i>Cassia lorentensis</i>	Leguminosae
* San Antonio		
Sachavaca papaya (papailla)	<i>Jacaratia cordata</i>	Bombacaceae
* Sapsa		
Sapote (sapotillo)	<i>Quararibea cordata</i>	Bombacaceae
* Shihuahuaco	<i>Dypterix micrantha</i>	Leguminosae
Shimbillo	<i>Inga</i> spp.	Leguminosae
Shimpa		
* Shiringa (jebe)	<i>Hevea brasiliensis</i>	Euphorbiaceae
Shishaco		
Super chacra		
Tahuari	<i>Anthodiscus pilosus</i>	Caryocaraceae
Tamamuri	<i>Naucleopsis glabra</i>	Moraceae
Tamarindo	<i>Tamarindus</i> spp.	Leguminosae
* Topa	<i>Ochroma pyramidale</i>	Bombacaceae
* Tornillo (Cedro Masha)	<i>Cedrelinga catenaeformis</i>	Leguminosae
Tortuga caspi	<i>Deguetia Tessmannii</i> (sp)	Annonaceae
Tuco		
Ubilla	<i>Pourouma cecropiaefolia</i>	Moraceae
* Ubo(s)	<i>Spondias mombin</i>	Anacardiaceae
* Uchu huayo		
Uchumullaca	<i>Trichilia japurensis</i>	Meliaceae
* Yanchama	<i>Poulsenia armata</i>	Moraceae
* Yerno en prueba	<i>Enterolobium cyclocarpum</i>	Leguminosae
* Yutubanco	<i>Heisteria calaneura</i>	Olcaceae

Adapted from the Asociacion de Extractores Forestales de Servicio y Comercializacion de Madre de Dios, Puerto Maldonado, June 1991.

SOURCES: Chudnoff, 1980 and personal investigations

* Recognized timber species

Appendix F

Agroecosystems for Madre de Dios:

A typical agroecosystem for the lowland tropical regions could be started with an initial cycle of pineapple (*Ananas comosus*), sugar cane (*Saccharum officinarum*), and beans (*Phaseolus* spp.) which could be followed by another cycle of "later succession" species such as cashew (*Anacardium occidentale*), bananas (*Musa* spp.), and papaya (*Carica papaya*). Forest tree species could be introduced simultaneously with this second cycle and could include a number of different palm species, valuable timber species, and other trees of extractive value such as Brazil nut (*Bertholetia excelsa*) and rubber (*Hevea brasiliensis*) (Newman, 1990). Following are listings of the species which have proven successful at other neotropical forest sites and may be applicable to a sustained-yield agroecosystem in Madre de Dios:

Non-timber Plants and Secondary Forest Products associated with Agroforestry Systems

Local Name	Scientific Name	Use
Achiote	<i>Bixa orellana</i>	dye
Aguaje	<i>Mauritia flexuosa</i>	fruit, flavoring
Aji	<i>Capsicum</i> spp.	seasoning
Aji dulce	<i>Capsicum</i> spp.	food
Ajinjibre, gengibre		seasoning
Arroz	<i>Oryza sativa</i>	food
Ayahuasca	<i>Banisteria caapi</i>	medicine
Barbasco	<i>Lonchocarpus nicou</i>	fish poison
Bijau	<i>Heliconia cannoidae</i>	food wrapping
Cacao	<i>Theobroma grandiflorum</i>	seasoning
Caihua	<i>Cyclanthera pedata</i>	food
Caimito	<i>Chrysophyllum caimito</i>	fruit

Agroforestry species continued:

Camote	<i>Ipomoea batatas</i>	food
Caña	<i>Saccharum officinarum</i>	juice, liquor, etc
Carambola	<i>Averrhoa carambola</i>	fruit, refreshment
Cashu	<i>Anacardium occidentale</i>	fruit
Castaña	<i>Bertholetia excelsa</i>	food, oil
Catirina	<i>Orbignya</i> spp. ?	construction
Chirimoya	<i>Annona cherimola</i>	fruit
Coco	<i>Cocos nucifera</i>	food
Cocona	<i>Solanum sessiliflorum</i>	refreshment
Coconilla (Cocona)	<i>Solanum topiro</i>	refreshment
Dale dale	<i>Calathea allouia</i>	food
Guaba	<i>Inga edulis</i>	fruit
Guarana	<i>Paullinia cupana</i>	refreshment
Guayaba	<i>Psidium guayab(v)</i>	fruit
Guineo, banana	<i>Musa</i> spp.	fruit
Guisador	<i>Canna</i> spp.	food coloring
Leche caspi	<i>Couma macrocarpa</i>	fruit, medicine
Limon	<i>Citrus</i> spp.	seasoning, juice
Lucuma	<i>Lucuma abovata</i>	fruit, flavoring
Macambo	<i>Theobroma bicolor</i>	food
Maiz	<i>Zea mays</i>	food
Maracuya	<i>Passiflora</i> spp.	fruit, refreshment
Melon	<i>Cucumis melo</i>	fruit
Palta	<i>Persea americana</i>	fruit
Pandillo (Pan de arbol)	<i>Artocarpus incisa</i> , <i>communis</i>	food
Papa huitina	<i>Xanthosoma</i> spp. ?	food
Papa pituca	<i>Colocasia esculenta</i>	food
Papaya	<i>Carica papaya</i>	fruit
Pif(j)uayo	<i>Bactris gasipaes</i>	food
Pina	<i>Ananas comosus</i>	fruit
Platano	<i>Musa</i> spp.	food
Pomarosa	<i>Eugenia jambos</i>	
Sacha mangua	<i>Grias neubertii</i>	fruit
Sacha papa	<i>Dioscorea</i> spp.	food
Sanango	<i>Sanago durum</i>	medecine
Shimbillo	<i>Inga</i> spp.	fruit
Sidra	<i>Citrus</i> spp.	fruit
Tabaco	<i>Nicotiana tabacum</i>	narcotic
Tamarindo	<i>Cyphomandra betacea</i>	fruit, refreshment
Tomate	<i>Solanum lycopersicum</i>	food
Totumo		utensils, storage
Tumbo	<i>Passiflora quadrangularis</i>	refreshment
Ub(v)a	<i>Pourouma cecropiaefolia</i>	fruit
Umari	<i>Poraqueiba sericea</i>	fruit
Ungurabe	<i>Jessenia batahua</i>	
Yuca	<i>Manihot esculenta</i>	food
Zapallo	<i>Cucurbita</i> spp.	food

(Adapted from Hiraoka, 1986 and INADE-APODESA, 1990)

IX. Tables and Figures

Table 1
Production of major crops in Madre de Dios, 1980-1990
(in metric tons)

Year	Rice	Corn	Yuca (Manioc)	Frijol (Beans)	Citrus	Plantain
* 1980	2502.0	765.0	2085.0	172.8	724.0	6600.0
1981	3814.5	987.0	9315.0	173.2	456.0	9456.0
1982	3712.5	864.0	7395.0	123.6	1120.0	8268.0
1983	3438.0	1072.0	11160.0	na	1175.0	9864.0
1984	4089.0	1410.0	13770.0	84.0	3030.0	10764.0
1985	6748.0	657.0	11640.0	104.0	2250.0	9132.0
1986	6964.5	1953.0	10530.0	188.8	2320.0	10512.0
1987	7203.0	1860.8	16395.0	328.8	3536.0	10050.0
1988	8917.4	3226.0	7404.0	170.4	1250.0	6007.5
1989	6479.2	3547.0	8502.0	390.4	4050.0	7009.0
1990	10348.5	3370.5	11595.0	256.0	770.0	7788.0

SOURCES: All estimates obtained from Miguel Frisancho, Ministry of Agriculture, Puerto Maldonado (unless otherwise noted).

* 1980 figures obtained from the "Diagnostico de Madre de Dios" published by the Subregion Madre de Dios.

Table 2

Average Yields of Rice, Maize, and Beans in Tropical Forest Locations Compared with other Regions of Peru, 1981.

(kg/ha)

Region or Department	*Rice	Beans	Maize
Loreto/Ucayali	1,964	1,029	1,622
San Martin	3,999	687	2,072
Madre de Dios	1,500	500	1,724
Chiclayo (coastal valley)	5,500	na	na
Region with greatest yield	8,361	1,299	4,372
Average national yield	4,757	873	2,745

* includes both upland and irrigated varieties

SOURCES: Adapted from Ministerio de Agricultura, 1982 and Villachica, 1990.

Table 3

Commercial interest rates used by the Banco Central de Reserva del Peru for the period September 1, 1983 through April 1, 1991

(interest rates are per cent)

Period	1 to 360 days	Up to 539 days	361 to 719 days	more than 720 days	Type of interest rate
09-01-83 to 12-14-84	80	--	--	--	Annual Nominal
12-15-84 to 01-31-85	66	--	--	--	Annual Nominal
02-01-85 to 06-30-85	72	--	--	--	Annual Nominal
07-01-85 to 08-04-85	90	--	--	--	Annual Nominal
08-05-85 to 08-25-85	110	--	--	--	Annual Effective
08-26-85 to 09-30-85	75	--	--	--	Annual Effective
10-01-85 to 02-15-86	45	--	--	--	Annual Effective
02-16-86 to 04-15-87	40	45	46	46	Annual Effective
04-16-87 to 07-15-87	40	51	53	55.5	Annual Effective
07-16-87 to 03-15-88	32	41	45	50	Annual Effective
03-16-88 to 05-15-88	55	--	55	75	Annual Effective
06-16-88 to 06-31-88	120	--	130	140	Annual Effective
09-01-88 to 11-30-88	255	--	270	300	Annual Effective
12-01-88 to 02-28-89	20	--	21	22	Monthly Effective
03-01-89 to 09-30-89	25	--	26	27.5	Monthly Effective
10-01-89 to 11-15-89	23.5	--	24.5	26	Monthly Effective
11-16-89 to 01-15-90	21.5	--	22.5	24	Monthly Effective
01-16-90 to 03-15-90	24	--	26	28	Monthly Effective
03-16-90 to 05-31-90	30	--	33	36	Monthly Effective
06-01-90 to 06-30-90	39	--	42	45	Monthly Effective
07-01-90 to 09-15-90	42.5	--	46.5	50.5	Monthly Effective
09-16-90 to 11-15-90	15	--	16	17	Monthly Effective
11-16-90 to 12-31-90	12.5	--	13.5	14.5	Monthly Effective
01-01-91 to 03-31-91	11.5	--	12.5	13.5	Monthly Effective
04-01-91 to ?	TAMN	--	TAMN+1	TAMN+2	Monthly Effective

SOURCE: Banco Central de Reserva del Peru, Cusco branch

Table 4a
Quantities for the Representative Farm Cash Flows

(All figures are for 1 hectare and 1 year agricultural cycle)
(Prices are in l/m or Nuevos Soles and US \$)

Item	Unit	Quantity	Unit Price	Total Price per hectare (l/m)	Total Price per hectare (US \$)
1 Area	hectare	1			
2 Production (sales)	kilograms	1500	0.124	186.00	332.14
3 Materials:					
4 Seed	kilograms	12	0.20	2.40	4.29
5 Fertilizer					
6 Herbicide (Hedonal)	litre	1	5.00	5.00	8.93
7 Machete	unit	1	2.50	2.50	4.46
8 Chainsaw	unit	1			
9 Gasoline	gallon	1	1.10	1.10	1.96
10					
11 Labor	person-days	1	2.30		
12					
13 Cultivation:					
14 Preparation of site					
15 Slash	person-days	10	2.30	23.00	41.07
16 Tree felling	person-days	20	2.30	46.00	82.14
17 Removal of debris	person-days	4	2.30	9.20	16.43
18 Burn	person-days	1	2.30	2.30	4.11
19 Planting	person-days	10	2.30	23.00	41.07
20 Replanting	person-days	3	2.30	6.90	12.32
21 Weeding	person-days	3	2.30	6.90	12.32
22 Applic. of herbicide	person-days	4	2.20	8.80	15.43
23 Harvest	person-days	15	2.30	34.50	61.61
24 Threshing	person-days	3	2.30	6.90	12.32
25 Fanning	person-days	3	2.30	6.90	12.32
26 Packaging	person-days	1	2.00	2.00	3.57
27 Other and unexpected	person-days	5	2.00	10.00	17.86
28					
29 Transportation	kilometers	25		75.00	88.24
30					
31 Other Activities:					
32 Gold mining:	grams				
33 Cash In	grams	104	9.50	988.00	1235.00
34 Cash Out	grams	104			
35 Net Cash Flow (Gold)	grams	104			
36 Wood extraction**	board feet				
37 Cash In	board feet	52500	0.18	9450.00	11117.65
38 Cash Out	board feet	52500	(see Table 4c)	7411.76	8719.72
39 Net Cash Flow (Wood)	board feet	52500	(see Table 4c)	2038.24	2397.92
40					
41 Loans (sostenimiento)	Annual	1	292.00	292.00	343.53
42 Loan Repayments					

*Commercial interest rate
(Real) for March 1991 =

0.274

* Subsidized interest rate

"sostenimiento"

(Real) for March 1991 =

0.086

** An individual will extract an average of 500 board feet/day during the farming off-season (May - September) and work approximately 105 days (pers. obs.)
The transport costs for wood extraction will assume the same distance from market than that of the representative farm.

Table 4b

Financial Cash Flow for a representative rice farm in Madre de Dios

(All figures for 1 hectare of rice on a newly cleared plot)

(Prices in US\$ to account for monthly variations of local prices)

Item	Rice Income w/out Credits and Subsidies	Rice and Add. Income w/out Credits and Subsidies	Rice Income with Credit and Subsidies	Rice and Add. Income with Credit and Subsidies
CASH IN				
Sales (900 or 1500 kg)	199.29	199.29	332.14	332.14
Loans (Banco Agrario)			343.53	343.53
Other Income:				
Wood Extraction		2397.92		2397.92
Gold Mining				
TOTAL CASH IN	199.29	2597.21	675.67	3073.60
CASH OUT				
Materials:				
Seed	4.29	4.29	4.29	4.29
Fertilizers	0.00	0.00	0.00	0.00
Herbicides (Hedonal)	8.93	8.93	8.93	8.93
Machete	4.46	4.46	4.46	4.46
Agric. activities (labor):				
Preparation of site:				
Slash	41.07	41.07	41.07	41.07
Tree felling	82.14	82.14	82.14	82.14
Removal of debris	16.43	16.43	16.43	16.43
Burn	4.11	4.11	4.11	4.11
Planting	41.07	41.07	41.07	41.07
Replanting	12.32	12.32	12.32	12.32
Weeding	12.32	12.32	12.32	12.32
Applic. of herbicide	16.43	16.43	16.43	16.43
Harvest	61.61	61.61	61.61	61.61
Threshing	12.32	12.32	12.32	12.32
Fanning	12.32	12.32	12.32	12.32
Packaging	3.57	3.57	3.57	3.57
Other (unexpected costs)	17.86	17.86	17.86	17.86
Transport to market	52.94	52.94	58.24	58.24
Fuel:				
Gasoline	1.96	1.96	1.96	1.96
Loan repayments	0.00	0.00	0.00	0.00
TOTAL CASH OUT	406.15	406.15	441.45	441.45
NET CASH FLOW	-206.87	2191.06	234.22	2632.15
PRESENT VALUE	-206.87	2191.06	234.22	2632.15

Table 4c

Transport and other costs for wood extraction

in l/m and US \$)

Distance from market (km)	Transport cost per trip (l/m)	Transport cost per trip (US \$)	Total transport cost for 105 trips per season (US \$)	Other costs* (l/m)	Other costs (US \$)	Total cost of wood extraction per season (US \$)
5	7.00	8.24	864.71	3150	3705.88	4570.59
10	14.00	16.47	1729.41	3150	3705.88	5435.29
15	20.00	23.53	2470.59	3150	3705.88	6176.47
20	27.50	32.35	3397.06	3150	3705.88	7102.94
25	30.00	35.29	3705.88	3150	3705.88	7411.76
30	37.50	44.12	4632.35	3150	3705.88	8338.24
35	42.50	50.00	5250.00	3150	3705.88	8955.88
40	50.00	58.82	6176.47	3150	3705.88	9882.35
45	57.50	67.65	7102.94	3150	3705.88	10808.82
50	60.00	70.59	7411.76	3150	3705.88	11117.65
55	65.00	76.47	8029.41	3150	3705.88	11735.29
60	70.00	82.35	8647.06	3150	3705.88	12352.94
70	80.00	94.12	9882.35	3150	3705.88	13588.24
more than 90	110.00	129.41	13588.24	3150	3705.88	17294.12

SOURCES: These figures were collected through interviews with farmers and truckers and from the Ministry of Agriculture

* Other costs include labor, fuel, maintenance of chainsaws, etc. These costs are assumed to be the same for all distances because they are independent of distance.

(By weight; 500 board feet = 1000 kg approx)

Table 4d

Sensitivity analysis of the Net Present Value (NPV) for varying distances from market and associated transport costs.

US \$ unless otherwise noted)

Distance from market (km)	NPV Rice Income w/out Credits and Subsidies	NPV Rice and Add. Income w/out Credits and Subsidies	NPV Rice Income with Credit and Subsidies	NPV Rice and Add. Income with Credit and Subsidies
5	-187.20	5588.50	300.40	5040.90
10	-173.80	4549.45	289.40	5012.60
15	-180.40	3670.83	278.30	4129.60
20	-193.60	2567.59	256.30	3017.50
25	-206.90	2191.06	234.20	2632.10
30	-220.10	1097.82	212.20	1520.10
35	-233.30	347.99	190.10	771.40
40	-246.80	-755.25	168.00	-340.60
45	-259.80	-1858.38	146.00	-1452.60
50	-273.00	-2235.02	123.90	-1838.00
60	-286.30	-2974.85	101.90	-2586.70

SOURCES: Own observations, Banco Agrario documents, and interviews.

Table 4e

Transportation costs for Agricultural Products (trucks)

(All prices in I/m for July 1991)

Kilometers	Price per trip	Price per bag (40 kg)	Price per ha of rice (1500 kg) at 37.5 bags/ha	Price per ha of rice (900 kg) at 22.5 bags/ha
5	7.000	0.500	18.750	13.235
10	14.000	0.750	28.125	19.853
15	20.000	1.000	37.500	26.471
20	27.500	1.500	56.250	39.706
25	30.000	2.000	75.000	52.941
30	*	2.500	93.750	66.176
35	*	3.000	112.500	79.412
40	*	3.500	131.250	92.647
45	*	4.000	150.000	105.882
50	*	4.500	168.750	119.118
60	**	5.000	187.500	132.353
90	**	110.000		

* Prices may vary depending on competition of transport vehicles.

** Transport distances exceeding 60 km are rare and uneconomical.

The trucks will generally carry a maximum load of about 1400 kg.

Note: The truckers will charge per trip or per bag depending on which one is greater. In this case, we are assuming a cost per bag because the entire rice production is being carried by a single truck in one trip (one trip = 1500 kg)

Table 4f

Sensitivity Analysis for varying loans from the Banco Agrario

(in US \$)

Amount of loan	NPV of representative farm*
100.00	-9.31
120.00	10.69
140.00	30.69
160.00	50.69
180.00	70.69
200.00	90.69
220.00	110.69
240.00	130.69
260.00	150.69
280.00	170.69
300.00	190.69
320.00	210.69
340.00	230.69
360.00	250.69
380.00	270.69
400.00	290.69

* This analysis has been completed for a farm located 25 km from Puerto Maldonado. The corresponding transport costs are used.

Table 5

Wood Extraction Volumes: Peru and selected regions, 1980 to 1989

(Sawnwood in cubic meters)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
National	606,594	643,343	523,977	380,083	474,348	524,736	606,656	612,798	536,327	387,567
Madre de Dios	19,399	16,944	14,220	13,160	19,041	24,804	37,871	39,499	22,226	22,390
Areto	21,336	39,986	33,281	21,320	30,398	19,041	40,522	39,895	40,172	40,583
Amazonas	6,921	9,537	4,475	2,287	3,725	6,380	7,994	3,014	1,560	---
Umo	4,684	4,366	5,515	5,743	6,235	5,969	9,436	11,266	9,003	9,599

SOURCE: FAO, 1991

Table 6

Forest Products: Imports and exports of selected Latin American countries, 1979 to 1989

(in US \$000s)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Exports											
South America	1,072,178	1,506,699	1,476,941	1,204,925	1,288,305	1,578,213	1,340,312	1,479,495	1,799,602	2,584,524	2,608,444
Bolivia	19,150	20,450	11,310	13,740	5,923	5,923	5,923	13,263	18,999	14,950	22,160
Peru	10,624	6,830	7,133	7,515	8,976	3,415	4,260	3,355	3,125	3,125	3,125
Brazil	591,287	864,664	944,317	685,384	822,032	1,027,080	800,615	936,349	1,115,945	1,759,977	1,750,981
Ecuador	9,278	27,334	28,487	28,672	16,169	18,657	11,547	15,342	21,145	22,536	21,496
Imports											
South America	1,019,447	1,284,923	1,331,109	1,283,009	975,158	968,696	840,342	949,008	1,086,693	1,223,587	978,604
Bolivia	10,305	11,805	12,605	5,800	5,800	4,800	4,300	5,100	6,800	4,100	4,060
Peru	26,616	37,829	57,034	74,314	48,145	44,278	37,449	57,079	84,404	87,828	87,828
Brazil	223,626	274,858	283,511	299,781	162,272	174,751	148,447	227,591	272,146	299,402	299,402
Ecuador	56,980	93,956	122,542	137,679	123,097	119,762	121,447	107,690	133,707	166,628	97,740

SOURCE: FAO, 1991

Table 7
The International Price of Gold, 1956 to 1985
 (US \$)

Year	Average Price for Year	Price in 1985 Dollars
1956	33.40	138.72
1957	33.13	134.66
1958	33.34	133.02
1959	33.26	132.70
1960	33.23	132.58
1961	33.38	133.18
1962	33.63	132.70
1963	34.17	133.20
1964	34.55	132.89
1965	36.42	137.66
1966	35.00	128.55
1967	35.00	124.82
1968	39.26	134.13
1969	42.19	136.39
1970	36.41	110.76
1971	41.25	120.07
1972	58.61	164.99
1973	97.81	258.24
1974	159.73	375.46
1975	161.49	344.83
1976	124.77	251.05
1977	147.87	278.34
1978	193.55	336.41
1979	307.51	474.41
1980	613.03	817.89
1981	459.61	549.30
1982	376.01	421.93
1983	423.83	460.85
1984	360.29	376.09
1985	317.00	317.00

SOURCE: Bullard, 1990

Table 7
The International Price of Gold, 1956 to 1985
 (US \$)

Year	Average Price for Year	Price in 1985 Dollars
1956	33.40	138.72
1957	33.13	134.86
1958	33.34	133.02
1959	33.26	132.70
1960	33.23	132.58
1961	33.38	133.18
1962	33.63	132.70
1963	34.17	133.20
1964	34.55	132.89
1965	36.42	137.66
1966	35.00	128.55
1967	35.00	124.92
1968	39.26	134.13
1969	42.19	136.39
1970	36.41	110.76
1971	41.25	120.07
1972	58.61	164.99
1973	97.81	258.24
1974	159.73	375.46
1975	161.49	344.83
1976	124.77	251.05
1977	147.87	278.34
1978	193.55	336.41
1979	307.51	474.41
1980	613.03	817.89
1981	459.61	549.30
1982	376.01	421.93
1983	423.83	460.85
1984	360.29	376.09
1985	317.00	317.00

SOURCE: Bullard, 1990

Table 9
Macroeconomic Indicators, First Quarter 1988-May 1991

(Millions of 1990 dollars and rates of change are monthly rates)

Period	Central Bank Net Internat. Reserves	Monetary base		M 1		Inflation (percent) Change	Deval. Export Rate (percent)	Lending Interest Rate (percent)	Real Export Rate (percent)	Real Minimum Wage (index)	GDP
		Nominal Change (percent)	Real Stock (index)	Nominal Change (percent)	Real Stock (index)						
1988: 1Q	-194	6.2	79.0	8.1	117.8	33.3	9.7	2.5	82.3	126.9	115.3
2Q	-180	7.6	72.2	6.5	104.5	11.7	22.1	4.2	105.3	113.5	120.4
3Q	-293	23.2	39.7	23.3	57.6	50.5	38.4	7.7	80.1	126.2	104.4
4Q	-352	24.5	30.7	27.3	47.7	35.4	33.5	13.5	80.0	90.4	92.9
1989: 1Q	-213	24.5	19.9	23.9	30.4	43.9	31.4	23.8	59.9	75.6	88.8
2Q	176	31.3	19.1	23.5	24.4	33.0	26.8	27.5	50.8	62.9	96.8
3Q	450	38.1	25.5	28.3	26.1	25.5	19.2	27.5	44.0	68.9	96.8
4Q	357	17.9	20.1	31.7	28.7	27.6	34.0	24.8	53.1	65.1	102.3
1990: Jan	301	17.2	18.2	5.4	23.3	29.6	-4.8	25.0	39.7	66.0	101.7
Feb	131	16.2	16.2	25.4	22.4	30.5	7.7	26.4	32.8	69.2	98.5
Mar	-37	42.8	17.4	33.9	22.6	32.6	36.9	29.7	33.7	67.8	97.4
Apr	-119	19.6	15.2	24.0	20.4	37.3	52.6	34.9	37.7	68.2	88.5
May	-152	37.7	15.7	30.1	20.0	32.8	32.3	36.0	38.0	69.8	113.3
Jun	-143	60.1	17.7	48.3	20.8	42.8	80.3	46.8	47.9	65.6	88.8
Jul	-105	43.6	15.5	67.7	21.4	63.2	53.7	51.0	46.1	63.1	87.7
Aug	142	174.0	8.6	105.9	8.9	397.0	242.7	51.0	32.4	50.7	79.9
Sep	427	81.1	13.6	66.8	13.0	13.8	55.7	40.0	45.0	69.7	72.8
Oct	565	33.1	16.6	39.7	16.5	9.6	2.9	18.0	43.3	63.6	88.3
Nov	572	6.7	16.7	6.5	16.6	5.9	-1.5	15.5	41.9	60.0	92.4
Dec	531	1.2	13.6	38.8	18.7	23.7	16.3	15.8	38.0	48.5	92.3
1991: Jan	451	1.3	11.7	-11.2	14.1	17.8	2.9	18.7	33.3	62.6	92.6
Feb	419	6.8	11.4	-0.4	12.8	9.4	3.8	24.6	32.0	57.2	90.0
Mar	499	13.3	12.0	20.0	14.2	7.7	1.9	27.4	29.3	53.1	88.1
Apr	599	3.6	11.8	14.0	15.3	5.8	12.7	22.7	30.7	50.2	91.1
May	623	1.5	11.1	6.0	15.1	7.6	27.4	18.3	36.3	46.7	112.6

SOURCES: Banco Central de Reserva del Peru, Nota Semanal (1988-1991)

(Adapted from Paredes and Sachs, 1991)

Table 9
pH, % Al saturation, % base saturation, and CEC
for Selected Soils of the Peruvian Amazon

Location and classification	Horizon	Depth cm	pH	Clay %	ECEC	CEC/100 g clay		Exchange acidity	
			H ₂ O			soil pH	ph 8.2 cmol(+)/kg	Al	H
Madre de Dios:									
Level upland									
Carretera (road) (Typic Paleustult)	A	0-9	3.9	26.8	5.0	19	23	4.1	0.5
	BA	9-25	3.9	30.4	5.1	17	37	4.2	0.8
	Bt1	25-52	4.2	39.0	6.7	17	33	5.3	1.0
*Estacion (Typic Paleustult)	Ap	0-9	4.3	2.8	1.5	53	101	0.3	0.3
	E	9-24	3.9	2.4	1.7	73	153	1.0	0.3
	BE	24-53	3.9	5.4	2.3	43	90	1.7	0.2
Upland side slopes									
Astillero (Typic Paleustult)	Ap	0-9	4.0	21.1	3.9	19	32	2.1	0.3
	Bt1	9-29	3.8	31.2	4.3	14	—	3.5	0.6
	Bt2	29-65	3.9	29.9	4.4	15	19	3.6	0.7
Amable (Typic Paleustult)	A	0-8	4.2	0.8	1.8	219	834	0.9	0.7
	AB	8-21	4.0	3.0	2.5	82	244	1.5	0.9
	Bt1	21-33	3.8	9.5	3.0	32	62	1.9	1.0
Recent flood plain									
Laberinto (Aeric Plaquod)	A	0-14	4.4	7.4	0.9	12	59	0.2	0.3
	E	14-23	5.4	4.0	0.8	19	86	0.0	0.0
	Bw	23-30	5.5	3.5	1.2	35	163	0.0	0.0
	Bhs	30-43	5.6	6.7	1.5	22	77	0.0	0.0
Urimaguas:									
Upland site at the research station (Typic Paleudult)	A	0-10	4.4	6	3.30	na	na	na	na
		10-30	4.4	13	3.82	na	na	na	na
		30-50	4.6	16	4.45	na	na	na	na
Poorly-drained site of flat-top hills (Aquic Paleudult)	A1	0-9	4.4	15	4.2	na	na	0.0	na
	A2	9-20	4.4	19	5.8	na	na	0.1	na
	B21	20-43	3.9	35	13.0	na	na	5.9	na
Well-drained site on level upland (Typic Paleudult)	A1	0-7	4.0	15	2.7	na	na	0.8	na
	B1	7-48	3.5	23	4.1	na	na	3.2	na
	B21	48-67	3.5	25	5.4	na	na	4.4	na
Uritos:									
Poorly-drained site close to Amazon riv (Typic Paleudult)	A1	0-16	4.0	30	7.4	na	na	5.9	na
	B1	16-35	4.5	40	7.4	na	na	5.7	na
	B21	35-70	4.3	54	9.9	na	na	9.5	na
Flood plain terrace (Fluventic Haplaq.)	A	0-10	6.0	24	14.5	na	na	0.0	na
	?	10-50	6.1	20	15.8	na	na	0.0	na
	?	50-120+	6.3	10	9.5	na	na	0.0	na

(Adapted from Newman 1985, Sanchez 1989, and Sanchez and Buol 1974)

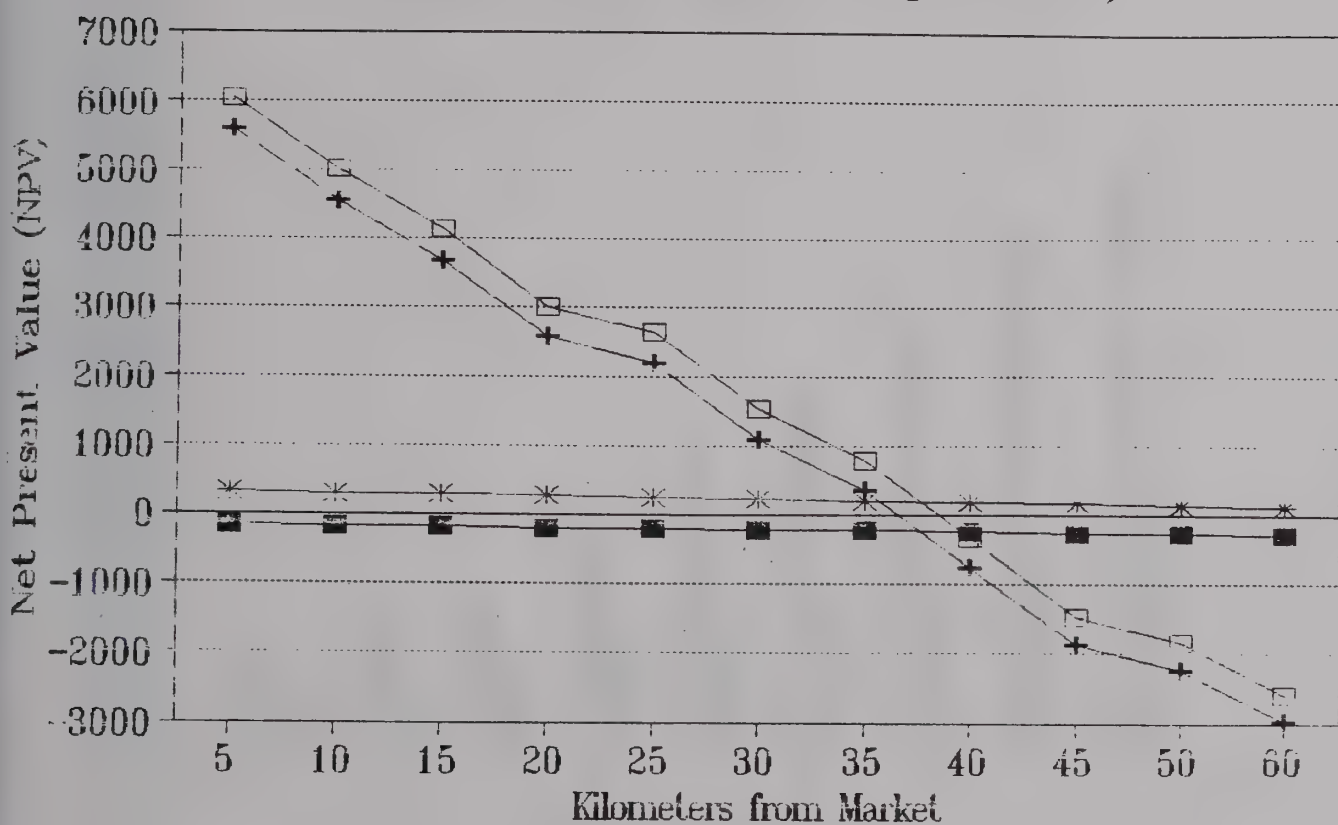
Table 10
Production schedule for Upland Rice

Zone	Cut and burn	Planting	Remove weeds	Pest control	Harvest	Threshing & Fanning	Transport to market
1) Beach	n.a.	May	n.a.	August	September	October	November
2) Alluvial sites	June-July	August-Sept.	October	December	January	February	March
3) Upland sites	June-July	Sept.-Octobe	November	January	Feb.-March	March	April

Sources: Adapted from CIPA, 1988 and own investigations

Figure 1

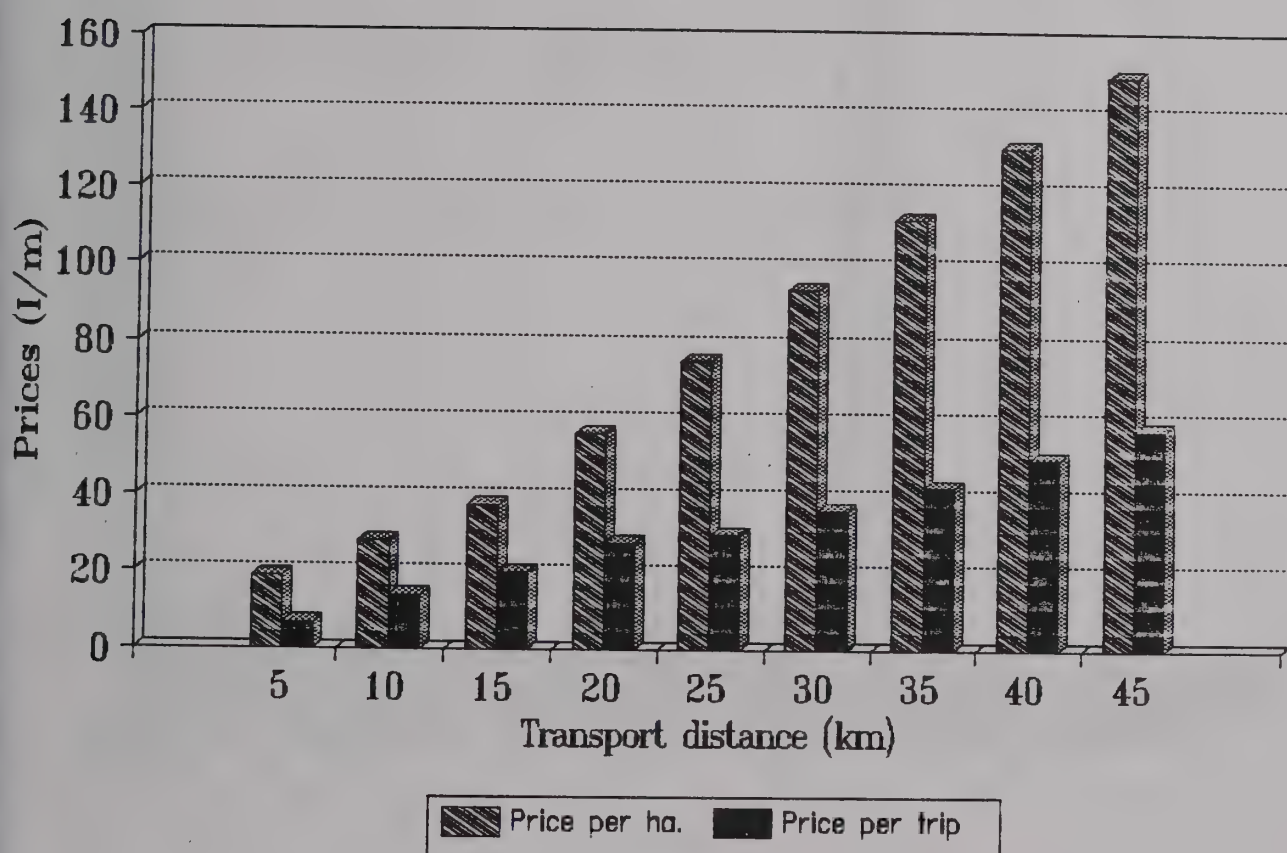
Distance from Market *Sensitivity Analysis (Transport costs)*



■ Rice inc w/out loan + All inc. w/out loan * Rice with loan □ All inc. with loan

Figure 2

Transport Costs for 1 Hectare of Upland Rice (1500 kg)



Inflation and Lending Interest Rates

First Quarter 1988 to May 1991



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